NEW

# LUNAR TABLES,

FOR CORRECTING THE

APPARENT DISTANCE OF THE MOON

FROM THE

SUN, FIXED STAR, OR PLANET,

FOR THE EFFECTS OF

REFRACTION AND PARALLAX,

ILLUSTRATED BY APPROPRIATE RULES AND EXAMPLES,

WITH PLAIN AND EASY DIRECTIONS FOR

TAKING A LUNAR OBSERVATION,

AND SOME USEFUL REMARKS ON THE SEXTANT.

TO WHICH IS ADDED, A NEW, EASY, AND ACCURATE METHOD OF

FINDING THE LATITUDE BY DOUBLE ALTITUDES.

ALSO,

A NEW AND INFALLIBLE METHOD OF BECOMING ACQUAINTED WITH

THE PRINCIPAL FIXED STARS,

AND OF FINDING THE LATITUDE BY THEM AT SEA,

WITH TABLES

CALCULATED FOR THE PURPOSE.

BY E. C. WARD,

PROF. MATH., &c., U. S. N. S., BROOKLYN, N. Y.

SEVENTH STEREOTYPE EDITION,

NEW YORK:
PUBLISHED BY E. & G. W. BLUNT,
HYDROGRAPHERS, CHART AND NAUTICAL INSTRUMENT SELLERS,
No. 179 Water Street, corner of Burling Slip.
1851.

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Entered according to Act of Congress, on the 18th day of October, 1833, by E. & G. W. Blunt, in the District Clerk's Office for the Southern District of New York.

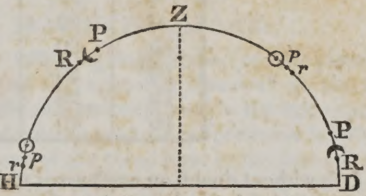
J. M. Elliott Printer, 133 Water Street, N. Y.

# PREFACE.

THE method of ascertaining the Longitude at sea by Lunar Observations, is of such great importance to the Navigator in traversing the wide and trackless ocean, that the practice thereof cannot be too strongly recommended. Various methods have been proposed to render the solution of this Problem easy and practicable, yet many are deterred from deducing the Longitude from Observation, on account of the supposed difficulty in making the necessary calculations: in order to remove those apparent objections the following Tables have been calculated, and adapted to Lyon's method, which is universally acknowledged to be the most concise and easy method of calculating the true distance, by corrections, ever offered to the Nautical Student.

The principle of this method is to clear the apparent distance from the effects of refraction and parallax, by means of corrections. The apparent altitudes of the heavenly bodies are affected by refraction and parallax, which operate only in a vertical direction, yet the apparent distance between any two bodies, will also be affected by these causes. All celestial objects, except the moon, are more affected by refraction than by parallax, and therefore appear *above* their true places; but the moon, being more affected by parallax than refraction, is always seen *below* her true place. I will now endeavour to show, in a plain and familiar manner, how the apparent distance is affected by refraction and parallax; also how the accuracy of this, or any other method may be proved.

When the moon and the sun, star, or planet,* are in the same azimuth circle, that is, when the sum of the distance and the less altitude is equal to the greater altitude, as in the annexed figure, the correctness of any method may be proved, as follows: Let H ⊙ be the sun's apparent altitude=12°, H ☽ the moon's apparent altitude=52°, and ⊙ ☽ the apparent distance=40°, and the ☽'s horizontal parallax=54′; then ⊙ *r* is the refraction of the sun=4′.23″, and ☽ R the refraction of the moon=0′.44″; in this case, the sun's refraction being greater than the moon's, the difference of the refractions 3′.39″ must be added to the apparent distance 40°, and the sum R *r* will be the distance corrected for refraction=40°.3′.39″. Again, let D ☽ be the moon's apparent altitude=12°, D ⊙ the sun's apparent altitude=52°, and ☽ ⊙ the apparent distance=40° as before, and the ☽'s horizontal parallax=54′; in this situation also, the difference of the refractions 3′.39″ must be added to the apparent distance, and the sum R *r* will be the distance corrected for refraction=40°.3′.39″, as before.



In the first case, R P is the moon's parallax in altitude=33′.15″, and as the moon is the higher body, it must be added to R *r* the distance corrected for refraction, and the sum *r* P= 40°.36′.54″, will be the distance corrected for the moon's parallax in altitude; *r p*=8″ is the effect of the sun's parallax, which is to be subtracted from *r* P, the distance corrected for refraction and the moon's parallax, and the difference P *p*=40°. 36′.46″ will be the true distance.

In the second case, the moon being the lower body, the moon's parallax in altitude R *p*= 52′.49″ must be subtracted from R *r* and the difference, P *r*=39°.10′.50″ will be the distance corrected for refraction and the moon's parallax, and *r p*=5″, the sun's parallax in altitude, is to be added, and the sum P *p*=39°.10′.55″ will be the true distance.

When the moon, and the sun, &c. are on the same meridian, but on opposite sides of the zenith, that is, when the sum of the altitudes and distance is equal to 180°, as in the figure, where H ☽ and D ⊙ are each equal to 52°, and the distance ☽ ⊙=76°, the sum of the sun and moon's refraction 1′.30″ is to be added to the apparent distance, and the sum R *r*=76°.1′.30″ will be the distance corrected for refraction. In this case, the sum of the moon and sun's parallaxes in altitude 33′.14″ and 5″=33′.19″, must be subtracted from 76°.1′.30″, the distance corrected for refraction, and the sum P *p*=75°.28′.11″ will be the true distance.

When the moon and sun, &c. are in the before mentioned situations, no triangle is formed; but when they are in any other position, they form a spheric triangle with respect to the zenith of the place of observation. Table I. is calculated to give the effect of refraction in distance to the nearest second in every position of these bodies; and Table V. gives the effect of the sun's parallax in distance. The only correction to be calculated, is the effect of the moon's parallax in distance. An example in each of those cases is worked out by these Tables, which exactly corresponds with the above.

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* Tables containing the moon's distances from the planets Venus, Mars, Jupiter, and Saturn, are now published annually in Europe

Tables to give the effect of refraction in distance have been published by Lyon, Norie, and Delamar; these differ in construction, but give nearly an accurate result; also by Turner, Elford, Heartie, &c. which contain so many errors, both in principle and in arrangement, that they are neither adapted for the teacher, nor for the Navigator. With respect to the arrangement of Elford and Turner's Tables, the following example from Elford may suffice :—

Distance 30°, the less altitude between 10° and 14°, and the greater altitude between 29° and 35° inclusive, the correction is 2′.15″, not varying *one second in six degrees* of the greater altitude; now the distance and the less altitude remaining the same, and the greater altitude between 36° and 45°, the correction is 3′.10″; thus it appears that from 35° to 36° of the greater altitude, the correction changes from 2′.15″ to 3′.10″, that is 55″ *in one degree*, equal to 25 miles of longitude.

In Patten's edition of Turner's Tables, lately published :—Distance 40°, less altitude from 7° to 10°, and the greater altitude from 10° to 20°, the correction is 1′.40″; and in the next page, the same distance and altitudes give 1′.16″, which error is continued from 40° to 50° of distance; and it is rather singular that in both of these Tables, the less and greater altitudes as above, the correction is 40″ too great from 20° to 60° of distance, where they then begin to be nearly right. The following are a few of the many errors with which these Tables abound :—

| Less Altitude. | Greater Altitude. | Distance. | True Correction. | Elford. | Patten's ed. of Turner. |
|---|---|---|---|---|---|
| ° | ° | ° | ′ ″ | ′ ″ | ′ ″ |
| 8 | 52 | 120 | 7.15 | 6.40 | 7.10 |
| 9 | 59 | 50 | 5.15 | 5.40 | 4.28 |
| 10 | 80 | 90 | 5.25 | 4.35 | 4.32 |
| 10 | 50 | 40 | 4.27 | 3.40 | 3.30 |
| 12 | 26 | 20 | 1.53 | 1.10 | 1.10 |
| 16 | 40 | 30 | 1.50 | 1.45 | 1.30 |

It is without doubt, an unpleasant task to expose the errors of other writers; yet, as a Teacher of Nautical Science, and in friendship to the industrious and scientific Navigator, whose arduous avocation will not allow him time to investigate the merits or demerits of Nautical Works, I consider it my duty to guard him against inaccuracy, and present him with a new set of Tables, which I trust will meet his approbation and encouragement.

E. C. WARD.

*New-York, April,* 1823.

# DESCRIPTION AND USE

# OF THE

# TABLES.

## TO FIND THE EFFECT OF REFRACTION.

ENTER Table I. with the nearest degree of the less altitude in the first column, the next less degree of the greater altitude in the second column, and the next less degree of the apparent distance at the top, and take out the corresponding correction; find the difference between this correction and the next below it, and the next to the right. Enter Table II. with the first difference at the top, and the overplus degrees of the greater altitude at the side, and take out a number of seconds, to be added to the above correction; enter this Table again with the second difference at the top, and the overplus degrees of distance at the side, and take out another number of seconds, to be added to the above sum, if increasing, but subtracted if decreasing, and the result will be the first correction, or the effect of refraction in distance, and is always to be added to the apparent distance.

When the less altitude is small, it may be necessary to take out the correction for the next less and next greater degree, and proportion for the minutes. When the greater altitude exceeds 80°, allow the same difference from 80° to 90° as in the preceding 5°, and proportion accordingly.

## TO FIND THE EFFECT OF THE MOON'S PARALLAX.

Take from a Table of log. sines, tangents, &c. the following logarithms, (to four places of figures,) which arrange in two columns, viz. the sine of the apparent distance* in the first column, and the tangent in the second; the cosecant of the sun, star, or planet† in the first column, the cosecant of the moon's apparent altitude in the second column, and the proportional logarithm of the moon's horizontal parallax in both columns: the sum of the three logs. in the first column, will be the pro. log. of arch A, and the sum of the three logs. in the second column, will be the pro. log. of arch B.

When the apparent distance is less than 90°, the difference between these two arcs is the second correction, or the principal effect of the moon's parallax in distance; but when the distance exceeds 90°, the sum of these two arcs is to be used. Always subtract the second correction from the distance corrected for refraction, except when arch A is less than arch B, in which case, it is to be added, and the result will be the distance corrected for refraction, and the principal effects of the moon's parallax.

With the moon's altitude and horizontal parallax, enter Table III. and take out her parallax in altitude. Enter Table IV. with the apparent distance at the top, and take out the numbers opposite to the moon's parallax in altitude, and to the second correction, and their difference will be the third correction, which is to be added to the second corrected distance, if it be less than 90°, and subtracted when greater; the sum or difference will be the *true angular distance* between the moon and a star, or planet.

But, if the moon's distance from the sun be observed, enter Table V. with the distance at the top, the moon's altitude in the first column, and the sun's in the second, and take out the corresponding number, which is the effect of the sun's parallax in distance, and is to be added or subtracted, as directed in the Table.

### EXAMPLE I.

| | | ° ′ ″ | |
|---|---|---|---|
| **Given** | Apparent Distance - | 40.0.0 | **to find the True Distance.** |
| | ☉'s App. Altitude - - | 12.0.0 | |
| | ☽'s App. Altitude - | 52.0.0 | |
| | ☽'s Hor. Parallax - - | 54.0 | |

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* All writers on this method have erroneously made use of the sine and tangent of the first corrected distance instead of the apparent, which will not stand the test of demonstration.

† App. Altitude.

In Table I. the correction answering to 12° the less altitude, 50° the next less degree of the greater altitude, and 40° the apparent distance, is 3′.31″; the difference between this and the next below it is 19″; in Table II. opposite 2° the overplus of the greater altitude above 50°, and under 19″ the difference is 8″, which being added to 3′.31″ will give 3′.39″ the first corrrection.

| | ′ ″ | | |
|---|---|---|---|
| App. Distance, Sine and Tang. | | 9.8081 | 9.9238 |
| ⊙'s App. Altitude, Cosecant | | 6821 | |
| ☽'s App. Altitude, Cosecant | | | 1034 |
| ☽'s Hor. Parallax | | PL 5229 | 5229 |
| Arch A | 17.28 | PL 1.0131 | |
| Arch B | 50.43 | | PL 5502 |
| 2nd Corr. | 33.15 | | |

| | ° ′ ″ |
|---|---|
| App. Distance | 40. 0. 0 |
| 1st Corr. | + 3.39 |
| 1st Corr. Distance | 40. 3.39 |
| 2d Corr. | + 33.15 |
| 2nd Corr. Distance | 40.36.54 |
| 4th Corr. | — 8 |
| True Distance | 40.36.46 |

This agrees with Stansbury's method. Elford differs 4″, and Turner 6″.

## EXAMPLE II.

| | | ° ′ ″ | |
|---|---|---|---|
| Given | Apparent Distance | 40. 0.0 | to find the True Distance. |
| | ⊙'s App. Altitude | 52. 0.0 | |
| | ☽'s App. Altitude | 12. 0.0 | |
| | ☽'s Hor. Parallax | 54.0 | |

| | ′ ″ | | |
|---|---|---|---|
| App. Distance, Sine and Tang. | | 9.8081 | 9.9238 |
| ⊙'s App. Altitude, Cosecant | | 1034 | |
| ☽'s App. Altitude, Cosecant | | | 6821 |
| ☽'s Hor. Parallax | | PL 5229 | 5229 |
| Arch A | 66.12 | PL 4344 | |
| Arch B | 13.23 | | PL 1.1288 |
| 2nd Corr. | 52.49 | | |

| | ° ′ ″ |
|---|---|
| App. Distance | 40. 0. 0 |
| 1st Corr. | + 3.39 |
| 1st Corr. Distance | 40. 3.39 |
| 2d Corr. | — 52.49 |
| 2nd Corr. distance | 39.10.50 |
| 4th Corr. | + 5 |
| True Distance | 39.10.55 |

This differs ½″ from Stansbury's method. Elford differs 2″ and Turner 12″.

## EXAMPLE III.

| | | ° ′ ″ | |
|---|---|---|---|
| Given | Apparent Distance | 76. 0.0 | to find the True Distance. |
| | ⊙'s App. Altitude | 52. 0.0 | |
| | ☽'s App. Altitude | 52. 0.0 | |
| | ☽'s Hor. Parallax | 54.0 | |

| | ′ ″ | | |
|---|---|---|---|
| App. Distance, Sine and Tang. | | 9.9869 | 6032 |
| ⊙'s App. Altitude, Cosecant | | 1035 | |
| ☽'s App. Altitude, Cosecant | | | 1035 |
| ☽'s Hor. Parallax | | PL 5229 | 5229 |
| Arch A | 43.51 | PL 6133 | |
| Arch B | 10.37 | | PL 1.2296 |
| 2nd Corr. | 33.14 | | |

| | ° ′ ″ |
|---|---|
| App. Distance | 76. 0. 0 |
| 1st Corr. | + 1.30 |
| 1st Corr. Distance | 76. 1.30 |
| 2nd Corr. | — 33.14 |
| 2nd Corr. Distance | 75.28.16 |
| 4th Corr. | — 5 |
| True Distance | 75.28.11 |

This differs 1″ from Stansbury's method. Elford differs 7″, and Turner 1″.

## EXAMPLE IV.

| | | | |
|---|---|---|---|
| Given | Apparent Distance | 31.10.0 | to find the True Distance. |
| | ✱'s App. Altitude | 27.28.0 | |
| | ☽'s App. Altitude | 22. 4.0 | |
| | ☽'s Hor. Parallax | 61.9 | |

In Table I. the number answers to 22° the less altitude, 25° the next less degree of the greater altitude, and 30° the next less degree of the distance, is 0′.32″; the difference between this, and the next below it, is 6″, and the difference between the said number 0′.32″, and the next to the right, is also 6″. In Table II. opposite 3° the overplus of the greater altitude above 25°, and under 6″ the first difference is 4″, to be added to 0′.32″ gives 0′.36″; and opposite 1° the overplus of the distance above 30°, and under the second difference 6″ is 1″, which being added to 0′.36″, will give 0′.37″, the first correction.

| | | | | | |
|---|---|---|---|---|---|
| App. Distance, Sine and Tang. | | | 9.7139 | | 9.7816 |
| ✱'s App. Altitude, Cosecant | | | 3361 | | |
| ☽'s App. Altitude, Cosecant | | | | | 4252 |
| ☽'s Hor. Parallax | | PL | 4689 | | 4689 |
| | ′ ″ | | | | |
| Arch A | 54.30 | PL | 5189 | | |
| Arch B | 37.59 | | | PL | 6757 |
| 2d Corr. | 16.31 | | | | |

| | ° ′ ″ |
|---|---|
| App. Distance | 31.10. 0 |
| 1st Corr. | + 37 |
| 1st Corr. Distance | 31.10.37 |
| 2d Corr. | — 16.31 |
| 2nd Corr. Distance | 30.54. 6 |
| 3rd Corr. | + 42 |
| True Distance | 30.54.48 |

This differs 1″ from Stansbury's Tables. Elford differs 44½″, and Turner 42½″.

## EXAMPLE V.

| | | | |
|---|---|---|---|
| Given | Apparent Distance | 25. 0. 0 | to find the True Distance. |
| | ⊙'s App. Altitude | 16. 0. 0 | |
| | ☽'s App. Altitude | 41. 0. 0 | |
| | ☽'s Hor. Parallax | 54.30 | |

In Table I. the number answering to 16° the less altitude, 40° the next less degree of the greater altitude, and 25° the apparent distance is 2′.7″; the difference between this and the next below it is 25″. In Table II. opposite 1°, the overplus of the greater altitude above 40° and under 25″ the above difference is 5″, which being added to 2′.7″ will give 2′.12″ the 1st correction.

| | | | | | |
|---|---|---|---|---|---|
| App. Distance, Sine and Tang. | | | 9.6259 | | 9.6687 |
| ⊙'s App. Altitude, Cosecant | | | 5597 | | |
| ☽'s App. Altitude, Cosecant | | | | | 1831 |
| ☽'s Hor. Parallax | | P L | 5189 | | 5189 |
| | ′ ″ | | | | |
| Arch A | 35.32 | PL | 7045 | | |
| Arch B | 76.40 | | | PL | 3707 |
| 2nd Corr. | 41. 8 | | | | |

| | ° ′ ″ |
|---|---|
| App. Distance | 25. 0. 0 |
| 1st Corr. | + 2.12 |
| 1st Corr. Distance | 25. 2.12 |
| 2nd Corr. | + 41. 8 |
| 2nd Corr. Distance | 25.43.20 |
| 4th Corr. | — 8 |
| True Distance | 25.43.12 |

This differs 1″ from Stansbury's Tables. Elford differs 43½″, Turner 53½″.

## EXAMPLE VI.

| | | | |
|---|---|---|---|
| Given | Apparent Distance | 118.27.37 | to find the True Distance. |
| | ⊙'s App. Altitude | 16.16. 0 | |
| | ☽'s App. Altitude | 26.51. 0 | |
| | ☽'s Hor. Parallax | 59.13 | |

In Table I. the number answering to 16° the less altitude, 25° the next less degree of the greater altitude, and 115° the next less degree of the distance, is 3′.8″; the difference between this, and the next below it, is 12″, and the difference between it and the next to the right is 19″. In Table II. opposite 2° the overplus of the greater altitude above 25°, and under 12″ the first difference, is 5″, to be added to 3′.8″, which gives 3′. 13″; and opposite 3½° the overplus of the distance above 115°, and under 19″ the second difference, is 13″, which being added to 3.′13″ will give 3′.26″ the first correction.

| | | | | |
|---|---|---|---|---|
| App. Distance, Sine and Tang. | | | 9.9440 | 2658 |
| ☉'s App. Altitude, Cosecant | | | 5527 | |
| ☽'s App. Altitude, Cosecant | | | | 3452 |
| ☽'s Hor. Parallax | | PL | 4828 | 4828 |
| | ′ ″ | | | |
| Arch A | 18.52 | PL | 9795 | |
| Arch B | 14.30 | | PL | 1.0938 |
| 2nd Corr. | 33.22 | | | |

| | ° ′ ″ |
|---|---|
| Apparent Distance | 118.27.37 |
| 1st Corr. | + 3.26 |
| 1st Corr. Distance | 118.31. 3 |
| 2nd Corr. | — 33.22 |
| 2nd Corr. Distance | 117.57.41 |
| 3rd Correction | — 8 |
| 3rd Corr. Distance | 117.57.33 |
| 4th Corr. | — 6 |
| True Distance | 117.57.27 |

**This differs 1″ from Stansbury's Tables. Elford differs 16″, and Turner 15″.**

## QUESTIONS FOR EXERCISE

| ☽'s App. Alt. | ☉ & ✱'s App. Alt. | ☽'s H. P. | App. Dist. | 1st Corr. | 2nd. Corr. | 3rd. Corr. | 4th. Corr. | True Dist. |
|---|---|---|---|---|---|---|---|---|
| ° ′ | ° ′ | ′ ″ | ° ′ ″ | ′ ″ | ′ ″ | ″ | ″ | ° ′ ″ |
| 28 21 | 25 48 | 54 36 | 44 55 14 | 0 48 | — 7 39½ | + 19 | — 2 | 44 48 39½ |
| 15 30 | 29 48 | 54 21 | 62 37 35 | 1 34 | —22 54 | + 10 | — 1 | 62 16 24 |
| 17 10 | 46 0 | 54 17 | 69 13 52 | 2 9 | —35 41 | + 5 | — 1 | 68 40 24 |
| 33 22 | 40 42 | 56 44 | 100 20 53 | 2 18 | —43 18½ | — 1 | — 5 | 99 39 46½ |
| 41 14 | 35 57 | 58 43 | 100 44 10 | 2 19 | —42 26 | 0 | — 7 | 100 3 56 |
| 19 43 | 45 33 | 55 58 | 106 46 43 | 3 8 | —47 26 | — 2 | — 4 | 106 2 19 |
| 34 50 | 26 25 | 59 10 | 108 14 30 | 2 41 | —38 51 | — 1½ | — 7 | 107 38 11½ |
| 26 0 | 12 0 | 54 0 | 20 0 0 | 1 54 | + 32 11½ | + 31½ | — 6 | 20 34 32 |
| 20 9 | 12 27 | 57 24 | 38 22 17 | 1 1 | + 5 3 | + 33 | — 3 | 38 28 51 |
| 38 1 | 24 0 | 56 30 | 48 40 0 | 1 6 | + 0 1½ | + 15 | — 4 | 48 41 18½ |
| 80 50 | 23 53 | 59 14 | 65 19 19 | 2 5 | + 0 30 | 0 | — 8 | 65 21 46 |
| 66 34 | 43 13 | 61 13 | 45 3 57 | 0 56 | — 3 12 | + 5 | | 45 1 46 |
| 46 18 | 27 43 | 59 33 | 54 57 35 | 1 10 | — 3 38½ | + 10 | | 54 55 16½ |
| 50 59 | 33 24 | 54 59 | 64 4 47 | 1 19 | —12 53 | + 4 | | 63 53 17 |
| 58 30 | 34 16 | 56 30 | 48 40 0 | 1 6 | + 0 1½ | + 7 | | 48 41 14½ |
| 41 15 | 11 10 | 55 30 | 70 56 49 | 3 3 | + 1 16 | + 5 | | 71 1 13 |
| 19 56 | 39 25 | 58 0 | 116 22 48 | 3 31 | — 50 55½ | — 1 | | 115 35 22 |

The examples above the line, are between the moon and the sun, and those below, between the moon and a fixed star.

The above questions are compared with Stansbury's and Rio's Tables, and are found to agree within a second; but on comparison with Elford, and Patten's edition of Turner's Tables, it appears they give the true distance in question 8, as much as *seventy-four* seconds too little.

## A NEW AND CONCISE METHOD OF FINDING THE SECOND CORRECTION, OR THE EFFECT OF THE MOON'S PARALLAX ON THE DISTANCE.

### RULE.

Add together the Sun and Moon's Apparent Altitudes, and the Apparent Distance; divide the sum by 2, and subtract the Sun's Apparent Altitude from the half sum, which call the remainder.

Add together the Log. Secant of the Moon's Apparent Altitude, the Log. Cosecant of the Apparent Distance, the Log. Cosine of the half sum, and the Log. Sine of the remainder, half the sum of these four Logarithms will be the Log. Sine of half an angle, which being doubled, will give angle M. then

Add together the Log. Secant of the angle M. the Log. Secant of the Moon's Apparent Altitude, and the Pro. Log. of the Moon's Horizontal Parallax, and the sum will be the Pro. Log. of the *second correction*, which is to be *subtracted* from the Apparent Distance corrected for the effects of refraction, when angle M is *less* than 90°; but to be *added* when angle M is *greater* than 90°.

### EXAMPLE IV.—*Page 7.*

| | | | |
|---|---|---|---|
| | ° ′ | | |
| ✱ App. Alt. | 27.28 | | |
| ☽ App. Alt. | 22. 4 | Secant | 0330 |
| App. Dist. | 31.10 | Cosecant | 2861 |
| Sum | 80.42 | | |
| Half Sum | 40.21 | Cosine | 9.8820 |
| Rem. | 12.53 | Sine | 9.3482 |
| | | | 2) 19.5493 |
| | ° ′ | | |
| | 36.31 | Sine | 9.7746 |
| | 2 | | |
| Angle M | 73.02 | Secant | 5349 |
| ☽ App. Alt. | | Secant | 0330 |
| | ′ ″ | | |
| ☽ Hor. Par. | 61. 9 | Pro. Log. | 4689 |
| | ′ ″ | | |
| 2d *Correction* | 16.32 | Pro. Log. | 1.0368 |

Which is *subtractive* because angle M is *less* than 90°.

### EXAMPLE VI.—*Page 7.*

| | | | |
|---|---|---|---|
| | ′ ″ | | |
| ☼'s App. Alt. | 16.16 | | |
| ☽'s App. Alt. | 26.51 | Secant | 0495 |
| App. Dist. | 118.28 | Cosecant | 0560 |
| Sum | 161.35 | | |
| Half Sum | 80.47 | Cosine | 9.2046 |
| Rem. | 64.31 | Sine | 9.9555 |
| | | | 2) 19.2656 |
| | ° ′ | | |
| | 25.25½ | Sine | 9.6328 |
| | 2 | | |
| Angle M | 50.51 | Secant | 1997 |
| ☽'s App. Alt. | | Secant | 0495 |
| | ′ ″ | | |
| ☽'s Hor. Par. | 59.13 | Pro. Log. | 4828 |
| | ′ ″ | | |
| 2d *Correction* | 33.22 | Pro. Log. | 7320 |

Which is *subtractive*, angle M being *lsss* than 90°.

### EXAMPLE IX.—*In Questions for Exercise, Page 7.*

| | | | |
|---|---|---|---|
| | ° ″ | | |
| ☼'s App. Alt. | 12.27 | | |
| ☽'s App. Alt. | 20. 9 | Secant | 0274 |
| App. Dist. | 38.22 | Cosecant | 2071 |
| Sum | 70.58 | | |
| Half Sum | 35.29 | Cosine | 9.9108 |
| Rem. | 23.02 | Sine | 9.5925 |
| | | | 2) 19.7378 |
| | ° ′ | | |
| | 47.41 | Sine | 9.8689 |
| | 2 | | |
| Angle M | 95.22 | Secant | 1.0290 |
| ☽'s App. Alt. | | Secant | 0274 |
| | ′ ″ | | |
| ☽'s Hor. Par. | 57.24 | Pro. Log. | 4964 |
| | ′ ′ | | |
| 2d *Correction* | 5. 2½ | Pro. Log. | 1.5528 |

Which is *additive*, because angle M is *greater* than 90°

# RULE TO CALCULATE THE LONGITUDE BY LUNAR OBSERVATIONS.

## PREPARATION.

If the time of observation be A. M., add 12 hours to it, and call the day of the month one less than the given day; but if it be P. M. put it down simply as it is, on the given day: multiply the longitude in by account, by 4, and divide by 60, the result will be the longitude in time, which must be added to the time of observation, if the longitude be W, but subtracted from it if E, and the sum or remainder will be the *estimate* Greenwich time.

If the Greenwich time exceed 24 hours, subtract 24 hours from it, and the remainder will be the time past noon on the following day; if the longitude in time be E, and greater than the time of observation, add 24 hours to the time of observation, subtract the longitude in time from it, and the remainder will be the time on the preceding day.

If the estimate Greenwich time be less than 12 hours, take from page VII. of the month in the Nautical Almanac,* the ☽'s horizontal parallax for noon and midnight of the given day; but if it be more than 12 and less than 24 hours, take out the ☽'s parallax for midnight of the given day, and the noon of the following day. Subtract the less from the greater, and the remainder will be the variation in 12 hours, enter Table XI. (Bowditch) with this variation at the side, and the Greenwich time at the top, and take out the proportional part, which *add* to the first horizontal parallax, if it be *increasing*, but *subtract* from it if *decreasing*, and the sum or remainder will be the ☽'s corrected horizontal parallax.

Take also from the Nautical Almanac the ☽'s horizontal semidiameter corresponding to the first horizontal parallax, to, or from which, add or subtract one-fourth of the proportional part of the hor. parallax, according as *it* was added or subtracted, and the result will be the ☽'s corrected semidiameter, to which add a number of seconds standing opposite the ☽'s altitude in Table XV. (B.,) and the sum will be the ☽'s augmented semidiameter.

To the ☽'s observed altitude, add 12′ if the lower limb was observed, but subtract 20′ from it if the upper limb was observed, and the sum or remainder will be the ☽'s apparent altitude. To the ☉'s observed altitude add 12′, but from the ✱'s observed altitude, subtract 4′, and the result will be the ☉ or ✱'s apparent altitude, from which subtract the refraction from Table XII. (B.,) and the remainder will be the ☉ or ✱'s true altitude.

To the observed distance of the ☽ and ☉, add the ☽'s augmented semidiameter, and the ☉'s semidiameter from page III. of the month in the N. A., and the sum will be the apparent distance; if the nearest limb of the ☽ was brought into contact with a ✱, add the ☽'s augmented semidiameter to the observed distance, but if the further limb of the ☽ was observed, subtract the ☽'s augm. semidiameter from the observed distance, and the remainder will be the apparent distance.

To find the true distance, see the explanation and use of the Tables, page 5.

## TO FIND THE APPARENT TIME AT GREENWICH.

Enter page VIII. or IX. of the month in the N. A., if the sun or star be east of the ☽, but page X. or XI. if they be west of her, and find those two distances on the given day that are next less and greater than the true distance found by calculation, which place under it; find the difference between the true distance and the first distance taken from the N. A., also the difference between the first and second distances, taken from the N. A.; take from Table XXII. (B.) the pro. log. of the two differences, subtract one from the other, and the remainder will be the pro. log. of a portion of time, to be added to the hour standing over the first distance in the N. A., and the sum will be the apparent time at Greenwich.

## TO FIND THE APPARENT TIME AT THE SHIP.

Take from Table XXVII. (B.) the secant of the latitude, and the secant of the ☉'s corrected declination,† and from Table XXIV. (B.) the nat. cosine of the sum of the latitude and declination when they are of different names, but the nat. cosine of the difference when of the same name, and the nat. sine of the ⊙'s true altitude, subtract the less from the greater, and take from Table XXVI. the logarithm of the difference, which place under the two secants, add the three logarithms together, and find the nearest log. rising in Table XXIII., and take out the corresponding hours, minutes and seconds, which will be the apparent time at the ship, if the observation was taken P. M., but if it was taken A. M., the time thus found must be subtracted from 24 hours, and the remainder will be the apparent time from the preceding noon.

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* The Nautical Almanac here alluded to, is examined and corrected by Mr. Daniel Stansbury, and published and sold by Edm. M. Blunt, 202 Water-street, and Geo. W. Blunt, 147 Fly-Market; it is, without exception, the most correct impression of this valuable work extant. In the Almanac for 1825, is a convenient practical rule for computing the latitude at sea, from the altitudes of two fixed stars observed at the same time.

† Take the ☉'s declination from page III. of the month in the N. A. for the noon of the given day, and enter Table V. (B.) with the Greenwich time at the top, and the day of the month at the side, and take out the corresponding correction, which must be added or subtracted, as directed at the top of the Table.

## TO FIND THE LONGITUDE.

When the longitude is W., subtract the app. time at the ship from the app. time at Greenwich; but when it is E. subtract the app. time at Greenwich from the app. time at the ship, and the difference being converted into motion, will be the longitude in, by observation.

## EXAMPLE I.

March 4th, 1824, in latitude 40°. 43′ N. and longitude 74°. 5′ W. at 10h. 21m. 30s. A. M. the observed altitude of the ☽'s upper limb was 30°. 18′, the observed altitude of the ⊙ 37°. 39′, and the observed distance between them 42°. 0′. 30″: required the longitude in.

| | h. m. s. |
|---|---|
| Time of Obs. 3rd - | 22.21.30 |
| Long. in time - | 4.56.20 |
| Sum - | 27.17.50 |
| Subtract | 24. 0. 0 |
| Estim. Greenw. T. 4th | 3.17.50 |
| | ° ′ |
| ☽'s Obs. altitude | 30.18 |
| Subtract - | — 20 |
| ☽'s App. altitude | 29.58 |

| | ′ ″ |
|---|---|
| ☽'s hor. par. noon - | 55.47 |
| ☽'s hor. par. midnight | 56. 3 |
| var. in 12 hours | 16 |
| pro. part in 3½ hours | + 4 |
| ☽'s cor. hor. par. - | 55.51 |
| ⊙'s Obs. altitude - | 37.39 |
| Add - - | + 12 |
| ⊙'s app. altitude - | 37.51 |
| Refract. | — 1 |
| ⊙'s true altitude | 37.50 |

| | | ° ′ ″ |
|---|---|---|
| | ☽'s Semidiam. noon | 15.12 |
| | ¼ of pro.part of hor. par. | + 1 |
| | ☽'s cor. Semidiam. - | 15.13 |
| | ☽'s augm. in altitude | + 8 |
| | ☽'s augm. Semidiam. | 15.21 |
| | ⊙'s Semidiam. - | 16. 8 |
| | Obs. Distance - | 42. 0.30 |
| | Apparent Distance | 42.31.59 |
| | 1st Cor. | + 48 |
| | 1st Cor. Distance | 42.32.47 |
| | 2nd Cor. | — 20.17½ |
| | 2d Cor. Distance | 42.12.29½ |
| | 3rd Cor. | + 18 |
| | 3rd Cor. Distance | 42.12.47½ |
| | 4th Cor. | 0 |
| | True Distance | 42.12.47½ |
| | Distance at 3 hours | 42. 4.18 |
| | Distance at 6 hours | 43.31.12 |
| 1.3263 PL | 1st difference - | 8.29½ |
| 3163 PL | 2nd difference - | 1.26.54 |
| 1.0100 | | |
| | ⊙'s declin. | 6.19.54 S |
| | Correction | — 3. 6 |
| | ⊙'s cor. dec. | 6.16.48 S |

| | | | | |
|---|---|---|---|---|
| App. Distance, sine and tangent - | | 9.8300 | | 9.9626 |
| ⊙'s apparent altitude, cosecant - | | 2121 | | |
| ☽'s apparent altitude, cosecant - | | | | 3015 |
| ☽'s hor. parallax - | PL | 5082 | | 5082 |
| Arch A 50.42 - | PL | 5503 | | |
| Arch B 30.24½ - | | | PL | 7723 |
| 2nd Cor. 20.17½ | | | | |

| | h. m. s. | |
|---|---|---|
| Portion of Time - | 0.17.35 | PL 1.0100 |
| Add - | 3 | |
| Apparent time at Greenwich | 3.17.35 | |

| | ° ′ | | |
|---|---|---|---|
| Latitude | 40.43 | N. Secant - | 12036 |
| ⊙'s correct dec. | 6.17 | S. Secant - | 00262 |
| Sum | 47. 0 | Nat. Cosine | 68200 |
| ⊙'s true alt. | 37 50 | Nat. Sine | 61337 |

| | | |
|---|---|---|
| | 6863 | log. 3.83651 |
| | h. m. s. | |
| | 1.38.35 | Rising 3.95949 |
| | 24. 0. 0 | |
| App. time of Observation | 22.21.25 | |
| App. time at Greenwich | 3.17.35 | |
| Longitude in Time | 4.56.10 = 74.2.30 W. | |

This differs ½″ in distance from Stansbury's method. Elford and Patten differ 17″.

### EXAMPLE II.

June the 17th, 1824, in latitude 32°.20′ N. and longitude by account 58°.30′ W. at 7h. 35m. 10s. A. M. the observed altitude of the ☽'s upper limb was 29°.50′, the observed altitude of the ⊙ 31°.26′, and the observed distance between them 114°.46′.50″: required the correct longitude in.

° ′ ″ h. m. s.
*Answer.*—App. Distance 115 . 17 . 30. App. Time at Greenwich, 16th, 23 . 31 . 58
True Distance 114 . 36 . 21. App. Time at Ship, 16th, 19 . 34 . 46
Longitude in 59°.18′ West.

## GENERAL DIRECTIONS FOR TAKING A LUNAR OBSERVATION.

THE observations necessary to determine the Longitude by the Lunar method, are the angular distance between the moon and the sun, star, or planet, in, or near the ecliptic, and the altitude of each. The instruments proper for taking these observations are, a Circle or Sextant to measure the distance between the objects, and two Quadrants to observe the altitude of each, at the same moment the distance was taken, for the purpose of clearing it from the effects of refraction and parallax. The correctness of a Lunar Observation depends chiefly on the exact measurement of the angular distance between the objects; therefore, previous to observation, the index error of the instruments must be accurately ascertained, especially that of the Sextant, for a small error in the altitudes will not materially affect the result of the calculation, but a mistake of a minute in the distance, will cause an error of nearly 30 miles of Longitude at the equator, and proportionably less in higher latitudes.

When a Lunar Observation is taken any time between half an hour after sunrise and 10 o'clock, A. M., or between 2 o'clock, P. M., and half an hour before sunset, the apparent time at the Ship may be deduced from the sun's altitude taken at the same time, therefore a watch is not required; but when the sun is near the meridian at the time of measuring the distance, the apparent time cannot be known from the altitude sufficiently correct for the purpose: in this case, a watch is absolutely necessary, for the sun's altitude should be observed when in a proper situation, either before or after the observation of the distance, for the express purpose of ascertaining the error of the watch, which must be applied to the time when the distance was taken, and the result of the operation will give the Longitude of that meridian, where the sun's altitude was observed to obtain the error of the watch.

The moon's angular distance from the stars can be taken more frequent than from the sun; and it is as easy to measure the distance between the moon and a star, as between the moon and the sun. These stellar observations ought not to be neglected, as they often afford the only means of knowing the Longitude of the Ship; for it frequently occurs, that during the day, the sun is obscured by a cloudy atmosphere, when at night the moon and stars shine with unsullied brightness: when the star is at a proper distance from the meridian, and the horizon clear and well defined, the apparent time at the Ship may be calculated from its altitude. The most correct altitudes of a star may be taken just before the rising, and after the setting of the sun, when the approaching or receding rays of that luminary serve sufficiently to enlighten and define the horizon, without affecting much the brilliancy of the star. When the horizon is not clear, the altitude of the star taken with the distance should not be used in calculating the time; the sun's altitude ought be taken for this purpose, either on the preceding afternoon, or the following morning. Hence the error of the watch may be known and applied as before mentioned.

If the distance between the moon and the sun be required, and the sun be to the Eastward of the moon, the sextant must be held with its face downwards; but if to the Westward, with its face upwards. Put the telescope in its place, and the wires parallel to the plain of the sextant, turn down one or more of the coloured glasses, according to the brightness of the sun, and direct the telescope to the moon, holding the sextant in such a position that its plane may pass through the moon and sun, an adjustment which is difficult, and requires considerable practice. Give the sextant a sweep or swing round the axis of the telescope, till the moon and sun are both seen in the field of the telescope, move the index backward and forward till the reflected limb of the sun is nearly in contact with the nearest limb of the moon, then fasten the index, and make them just touch at their external edges by means of the tangent screw, and the index will point out the observed or apparent distance of the nearest edges of the moon and sun.

If the distance be between the moon and a star or planet, and the star be to the Eastward of the moon,*the sextant must be held with its face upwards; but if the star be to the Westward, with its face downwards. Direct the telescope to the star, holding the sextant as before mentioned, and bring the enlightened limb of the moon, whether East or West, in contact with the star, by moving the index. To know whether the contact is perfect, gently vibrate the sextant, and let the star just graze the edge of the moon in passing and repassing, without entering at all the body of the moon, and the index will point out the apparent distance of the moon's nearest limb from the star.

*Note.*—From new to full moon, the enlightened limb is turned towards the West; and from full to new moon, it is turned towards the East.

When the Navigator is desirous of ascertaining the longitude of his ship by observation, he must first refer to the Nautical Almanac, to see if the moon and the sun be in distance; if not, see what star is in distance; then add, or subtract the longitude in time, to, or from, the time at the ship, according as it is W. or E., and the sum or difference will be the estimate Greenwich Time. Take from the N. A. the distance to the nearest degree, corresponding to the astronomical day of the month and the nearest third hour of the Greenwich time; fix the index of the Sextant to this distance, and at a convenient opportunity, the principal observer and his assistants are to be upon deck, provided with the proper instruments, and a black lead pencil and paper. All must observe at the same time, and during the observation each of the observers who takes the altitude must be careful to keep the lower or the upper limb of the object he is observing always in contact with the horizon, by means of the tangent screw of the index, and when the principal observer has brought the nearest limbs of the moon and the sun, or the enlightened limb of the moon and star or planet nearly into contact, he must ask his assistants if they are ready; if they answer "*ready*," then as soon as he has obtained a perfect coincidence of the limbs of the objects, he is to call out "*stop*," or "*done*." The person who has the watch must immediately write down the seconds, and then the minutes, the hour being previously written down: the principal observer is to read off the distance, and communicate the same to the time assistant, who must write it down abreast of the time of observation; the other assistants must also report the observed altitudes of the respective objects, naming whether the upper or lower limbs.

In this manner the observations must be repeated, till three or more different sets are obtained, which may be easily accomplished in eight or ten minutes; these sets ought to be taken about two minutes after each other, and the mean of the sets is to be used, that is, the sum of the sets must be divided by the number of sets, and the result will be the mean, from which the longitude is to be deduced, in the same manner as from a single set, but much more correct.

The most correct method of ascertaining the longitude by lunar observations, and indeed that which ought to be in general practice, is to dispense with the observations of the altitudes of the two objects, for they may be obtained with much greater accuracy by calculation, than from observation.

In finding the longitude by an observation of the distance only, the error of the watch must be ascertained by the sun's altitude, taken either before or after the observation of the distance; this error must be applied to the time of taking the distance, and the ☽ and ⊙ or ✱'s altitudes computed according to that time; the longitude is then to be calculated as usual.

## USEFUL REMARKS ON THE SEXTANT.

Observations taken with a sextant, are liable to errors, arising from the bending and elasticity of the index, and the resistance it meets with on turning round its center; for generally, the extremity of the index on being pushed along the arch, will sensibly advance before the index glass or the center begins to move, and will recoil when the force acting on it is removed. In order to obviate this error, the tangent screw of the index must always be moved in the same direction, that is, it must be turned the same way in finishing the observation, as in adjusting or finding the index error; for as the index was bent the same way, and in the same degree in adjusting as in observing, the error will vanish.

There is another error to which this instrument is liable, occasioned by the shades not being perfectly parallel and good; for by their different combinations, they give different index errors, and different distances: therefore, the same shades must be used in finding the index error, as will suit the observation. These errors seem inseparable from the construction and materials of the sextant, and are well known to the skilful and accurate observer.

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* And the objects to the Southward of the observer, but if to the Northward the reverse.

## EXAMPLES IN THE LUNAR OBSERVATIONS BY THE *NEW METHOD,* AND ADAPTED TO THE *NEW AND IMPROVED NAUTICAL ALMANAC.*

### EXAMPLE I.

September 8th, 1834, Latitude 38° 10′ N. and estimate Longitude 89° W. about 3h. 24m. P. M. the observed altitude of the ☽'s lower limb was 30° 39′, that of the ☼ 32° 45′, and the observed distance 72° 43′ 10″; error of the Sextant 30″ on the extra arch: required the Longitude in.

### PREPARATION.

| | | | | | |
|---|---|---|---|---|---|
| | h m | | ′ ″ | | ′ ″ |
| Time of Obs. | 3.24 | ☽'s Hor. Par. Noon | 59.25,7 | ☽'s Semidi. Noon | 16.11,7 |
| Long. in Time | 5,56 | ☽'s do Midn. | 59. 3,5 | ¼ Pro. Part. Cor. H.P. | 4 |
| *Greenw. Time* | 9.20 | Diff. | 22,2 | | 16. 8 |
| | | Pro. Part. | 17 | Augmentation | 8 |
| | | *☽'s Cor. Hor. Par.* | 59. 9 | *☽'s Cor. Semidi.* | 16 16 |
| | ° ′ | | ° ′ | | ° ′ ″ |
| ☽'s Obs. Alt. | 30.39 | ☼'s Obs. Alt. | 32.45 | Obs. Distance | 72.43.41 |
| Add | 12 | Add | 12 | Error of Sextant | + 30 |
| *☽'s App. Alt.* | 30.51 | *☼'s App. Alt.* | 32.57 | | 72.43.40 |
| | | | | ☽'s Semidiam. | + 16.16 |
| | | | | ☼'s do | + 15.54 |
| | | | | *App. Distance* | 73.15.50 |

### CALCULATION OF THE TRUE DISTANCE BY METHOD II.

| | | | |
|---|---|---|---|
| | ° ′ | | |
| ☼'s App. Alt. | 32.57 | | |
| ☽'s do | 30.51 | Secant | 0662 |
| App. Distance | 73.16 | Cosecant | 0188 |
| Sum | 137. 4 | | |
| Half Sum | 68.32 | Cosine | 9.5634 |
| Rem. | 35.35 | Sine | 9.7648 |
| | | | 2)19.4132 |
| | ° ′ | | |
| | 30.35 | Sine | 9.7066 |
| | 2 | | |
| Angle M. | 61.10 | Secant | 3167 |
| ☽'s App. Alt. | | Secant | 0662 |
| | ′ ″ | | |
| ☽'s Hor. Parallax | 59. 9 | Pro. Log. | 4833 |
| | ′ ″ | | |
| *2d Correction* | 24.30 | Pro. Log. | 8662 |

| | |
|---|---|
| | ° ′ ″ |
| App. Distance | 73.15.50 |
| 1st Cor. Table I. | + 1.25 |
| | 73.17.15 |
| 2d Cor. | + 24.30 |
| | 72.52.45 |
| 3d Cor. Table IV. | + 5 |
| | 72.52.50 |
| 4th Cor. Table V. | + 3 |
| *True Distance* | 72.52.47 |
| Dist. at 9h. N. Alm. | 72.40.49 |

| | | | |
|---|---|---|---|
| Pro. Log. Diff. | | 1.1773 | 11.58 |
| Pro. Log. N. A. | | 2649 | |
| | h m s | | |
| Pro. Log. | 0.22.1 | 9124 | |
| Add | 9. 0.0 | | |
| *Mean Time at Greenwich* | 9.22.1 | | |

### CALCULATION OF THE MEAN TIME OF OBSERVATION, &c.

| | | | | |
|---|---|---|---|---|
| ☼'s True Altitude | 32.57 | | | |
| Latitude | 38.10 | Secant | 10446 | |
| Polar Distance | 84.21 | Cosec | 00212 | |
| Sum | 155.28 | | | |
| Half Sum | 77.44 | Cosine | 9.32728 | |
| Rem. | 44.47 | Sine | 9.84784 | |
| | h m s | | 2)19.28170 | |
| App. Time of Obs. | 3.27.29 | Sine | 9.64085 | |
| Equation of Time. | —2.29 | | | |
| *Mean Time of Obs.* | 3.25. 0 | | | |
| *Mean Time at Greenw* | 9.22. 1 | ° ′ ″ | | |
| *Longitude in Time* | 5.57. 1 | = 89.15.15 | W. Longitude. | |

November 12th, 1834, Latitude 33° 45′ S. Longitude by account, 83° 45′ W. about 7h. 42m. P. M.; the observed altitude of the ☽'s lower limb was 43° 39′; the observed altitude of the Planet ♀ (Venus) 29° 58′, and the observed distance between their nearest limbs 101° 37′ 15″; error of the Sextant 45′ off the arch: required the Longitude in.

### PREPARATION.

| | | | | | |
|---|---|---|---|---|---|
| | h m | | ′ ″ | | ′ ″ |
| Time of Obs. | 7.25 | ☽'s Hor. Par. 12th Midn. | 54. 0.8 | Semidi. Midn. | 14.43. 1 |
| Long. in Time | 5.35 | ☽'s do 13th Noon | 53.59.4 | ¼ Pro. Part. Cor. Hor. Par. | 0 |
| *Greenw. Time* | 13. 0 | Diff. | 1.4 | | 14.43 |
| | | Pro. Part. | — 1 | Augmentation | 11 |
| | | *☽'s Cor. Hor. Par.* | 54. 0.7 | *☽'s Cor. Semidi.* | 14.54 |

| | |
|---|---|
| | ° ′ |
| ☽'s Obs. Alt. | 43.39 |
| Add | + 12 |
| ☽'s *App. Alt.* | 43.51 |

| | |
|---|---|
| | ° ′ |
| ♀'s Obs. Alt. | 29.58 |
| Dip. | — 4 |
| ♀'s *App. Alt.* | 29.54 |
| Refract | — 2 |
| ♀'*True Alt.* | 29.52 |

| | |
|---|---|
| | ° ′ ″ |
| Obs. Distance | 101.37.15 |
| Error of Sextant | + 45 |
| | 101.38. 0 |
| ☽'s Semidiam. | 14.54 |
| ♀'s Semidiam, N. A. | *19 |
| *App. Distance* | 101.53.13 |

## CALCULATION OF THE TRUE DISTANCE, BY METHOD I.

| | | | | | |
|---|---|---|---|---|---|
| | ° ′ | | | | |
| App. Dist. | 101.53 | Sine | 9.9906 | Tang. | 6768 |
| ♀'s App. Alt. | 29.54 | Cosec | 3023 | | |
| ☽'s App. Alt. | 43.51 | .................. | | Cosec. | 1594 |
| | ′ ″ | | | | |
| ☽'s Hor. Par. | 54. 1 | Pro. Log. | 5227 | Pro. Log. | 5227 |
| | ′ ″ | | | | |
| Arch A. | 37.31 | Pro. Log. | 8156 | | |
| Arch B. | 7.53 | .................. | | Pro. Log. | 3589 |
| *Second Cor.* | 35.24 | | | | |

| | |
|---|---|
| | ° ′ ″ |
| App. Dist. | 101.53.13 |
| 1st Cor. Tab. I. | + 2.26 |
| | 101.55.39 |
| 2d Cor. | — 35.24 |
| | 101.20.15 |
| 4th Cor. | — †15 |
| *True Distance* | 101.20. 0 |

## CALCULATION OF THE TRUE DISTANCE, &c. BY METHOD II.

| | | | |
|---|---|---|---|
| | ° ′ | | |
| ♀'s App. Alt. | 29.54 | | |
| ☽'s App. Alt. | 43.51 | Sec. | 1420 |
| App. Dist. | 101.53 | Cosec. | 0094 |
| Sum | 175.38 | | |
| Half Sum | 87.49 | Cosine | 8.5809 |
| Rem. | 57.55 | Sine | 9.9280 |
| | | | 2)18.6603 |
| | ° ′ | | |
| | 12.21 | Sine | 9.3301 |
| | 2 | | |
| Angle M. | 24.42 | Sec. | 0417 |
| ☽'s App. Alt. | | Sec. | 1420 |
| ☽'s Hor. Par. | | Pro. Log. | 5227 |
| | ′ ″ | | |
| *Second Cor.* | 35.23 | Pro. Log. | 7064 |

| | |
|---|---|
| | ° ′ ″ |
| App. Dist. | 101.53.13 |
| 1st Cor | + 2.26 |
| | 101.55.39 |
| 2d Cor. | — 35.23 |
| | 101.20.16 |
| 4th Cor. | — 15 |
| *True Distance* | 101.20. 1 |
| Dist. at 12h. N. A. | 100.51.32 |
| | 28.29 |

| | | |
|---|---|---|
| Pro. Log. of Diff. | | 8007 |
| Pro. Log. N. A. | | 3298 |
| | h m s | |
| P. L. | 1.0.52 | 4709 |
| Add. | 12 | |
| *Mean Time at Greenw.* | 13.0.52 | |

## CALCULATION OF THE MEAN TIME AT SHIP.

| | | | |
|---|---|---|---|
| | ° ′ | | |
| ♀'s True Alt. | 29.52 | | |
| Latitude | 33.45 | Secant | 08015 |
| ♀ Polar Dist. | 62.18 | Cosecant. | 05286 |
| Sum | 125.55 | | |
| Half Sum | 62.57 | Cosine | 9.65779 |
| Rem. | 33.05 | Sine | 9.73708 |
| | | | 2)19.52788 |
| | h m s | | |
| ♀'s Mer. Dist. | 4.44. 0 | Sine | 9.76394 |
| ♀'s R. Ascension. | 18. 6. 3 | | |
| R. Asc. of Mer. | 22.50. 3 | | |
| ☼'s R. Asc. | 15.11. 3 | | |
| App. Time of Obs. | 7.39. 0 | | |
| Equation of Time | — 15.37 | | |
| *Mean Time of Obs.* | 7.23.23 | | |
| *Do. at Greenw.* | 13. 0.52 | ° ′ ″ | |
| *Long. in Time* | 5.37.29 | = 84.22.15W. | |

| | |
|---|---|
| | ° ′ ″ |
| ♀'s Dec. 12th | 27.43.43S. |
| do 13th | 27.40.59S. |
| Diff. | 2.44 |
| Pro. Part. | 1.29 |
| ♀'s Cor. Dec. | 27.42.14S. |
| Subtract from | 90. 0. 0 |
| ♀'s *Pol. Dist.* | 62.17.46 |
| | h m s |
| ♀'s R. Ascension 12th | 18. 4.38 |
| Do 13th | 18. 7.15 |
| Diff. | 2.37 |
| Pro. Part. | 1.25 |
| ♀'s *Cor. R. Asc.* | 18. 6.03 |
| | h m s |
| ☼'s R. Asc. 12th | 15. 8.51 |
| Do 13th | 15.12.56 |
| Diff. | 4.05 |
| Pro. Part. | 2.12 |
| ☼'s *Cor. R. Asc.* | 15.11.03 |

---

* If the distance between the ☽'s enlightened limb and the centre of the Planet be observed, the Semidiameter of the Planet is not made use of.

† The effect of the Parallax of the Planets on the distance, may be obtained as follows: Take the Correction from Table V, as directed in page 5, which multiply by the Planet's horizontal Parallax, taken from the Nautical Almanac; divide the product by 9″, the quotient will be the effect of the Planet's Parallax on the distance, and is additive or subtractive, as directed in Table V.

## EXAMPLES FOR EXERCISE.

When the ☼, ✱, or Planet is at a proper distance from the Meridian at the time of measuring the Lunar Distance, and the Horizon well defined, the Mean Time at the place of Observation may be computed from its Altitude taken with the Distance, as in the following examples.

| Date Civ l Time. | Time By Watch. | Latitude. | Longitude. | Observed Altitudes. | Observed Distance. | True Distance. | *Answer.* Longitude. |
|---|---|---|---|---|---|---|---|
| Sept. 10<br>1834 | h m<br>4. 4. P.M. | ° ′<br>15. 7 S. | ° ′<br>53.30. W. | ° ′<br>☼ 25.45<br>☽ 55.35. U.L. | ° ′ ″<br>97.20.10 | ° ′ ″<br>97.22.28 | ° ′ ″<br>53.43.45 W. |
| Sept. 24<br>1834 | h m<br>7. 17. AM | ° ′<br>40.50. N. | ° ′<br>4. 0. E. | ° ′<br>☼ 15.24<br>☽ 48.11 .U.L. | ° ′ ″<br>110.52.10 | ° ′ ″<br>110.55.10 | ° ′ ″<br>3.48.45 E. |
| Sept. 29<br>1834 | h m<br>7. 43. AM | ° ′<br>28.10. N. | ° ′<br>82.30. W. | ° ′<br>☼ 23.26<br>☽ 37.44. L. L. | ° ′ ″<br>47. 2.30 | ° ′ ″<br>47.37. 0 | ° ′ ″<br>82.31.45 W. |
| Sept. 6<br>1834 | h m<br>3. 48. PM | ° ′<br>18.10. N. | ° ′<br>118.0. E. | ° ′<br>☼ 32.46<br>☽ 59.17. L. L. | ° ′ ″<br>37.36.50 | ° ′ ″<br>38.24.34 | ° ′ ″<br>118. 8.15 E. |
| Sept. 30<br>1834 | h m<br>6. 6. AM | ° ′<br>39.45. S. | °<br>104. E. | ° ′<br>Jupiter 23.40<br>☽ 12.14.LL | ° ′ ″<br>73.20.18<br>Further Limbs. | ° ′ ″<br>72.44.39 | ° ′ ″<br>103.34.15 E. |
| Sept. 22<br>1834 | h m<br>4. 10. AM | ° ′<br>35.15. N. | ° ′<br>36.15. W. | ° ′<br>Pollux 47.34<br>☽ 66.30.LL | ° ′ ″<br>65.55.45<br>Nearest Limb. | ° ′ ″<br>65.50.23 | ° ′<br>36.12 W. |

When the ☼, ✱, or Planet is too near the Meridian at the time of observing the Distance, the Mean Time at the Ship cannot be deduced from the Altitude with sufficient accuracy; it then becomes necessary to observe the Altitude of the ☼ when at a considerable distance from the Meridian, either before or after the Observation of the Distance, for the express purpose of finding the error of the Watch, which being *added* to the Time when the Distance was measured, if it was *slow*, but *subtracted*, if *fast*, will give the Mean Time at that Meridian where the ☼, ✱, or Planet's Altitude was observed, to find this error, at the instant when the Distance was observed. The Longitude deduced from this operation will be *that of the place where the error of the Watch was ascertained.* But, if the difference of Longitude *in time*, made in the interval between taking the Distance, and taking the Altitude for the error of the Watch, be *added* to the Time previously corrected by this error, when the Distance was observed to the *eastward* of the Altitude, or *subtracted*, when to the *westward;* the sum or difference will be the *Mean Time* at that station where the Distance was observed, and the Longitude deduced, will be that at the same station.

At night, when the Horizon is not well defined, the Time should never be calculated from the Altitude of a Star or Planet, but the error of the Watch must be ascertained as above.

It sometimes happens, that in measuring Lunar Distances, the Horizon is so much obscured, as to render it impossible to observe the Altitudes of the objects; and indeed, in some vessels the requisite assistants cannot be obtained to take them. In such cases, it becomes necessary *to compute the Altitudes* for the Mean Time of Observation of the Distance corrected for the error of the Watch as above

Whatever little additional trouble may attend this operation, it will be more than counterbalanced by the pleasing recollection that it affords the Navigator an opportunity of ascertaining the Longitude without depending upon any one for assistance, for the Watch may be held in the left hand, with the chain or ribbon twisted round the fingers, and a quick observer may mark the Time to a second. A little practice will soon render this (the best of methods,) easy and familiar.

In the following examples, the error of the Watch is deduced from the ☼'s Altitude, observed before or after the Distance, and the Altitudes for clearing the Distance are *computed*, the Longitude being required.

| Date Civil Time | Time by Watch. | Latitude. | Longitude. | ☼'s Obs Altitude. | Error of Watch. | Time by Watch when Distance was observed. | Observed Dist. | True Dist. | *Answer.* Longitude. |
|---|---|---|---|---|---|---|---|---|---|
| Sept. 12<br>1834 | h m s<br>3.40.12 P. M. | ° ′<br>28.14 N. | °<br>19 W. | ° ′<br>32.15 | m s<br>3.15<br>Fast. | h m s<br>4.7.10 P.M. | ° ′ ″<br>120.22.10 | ° ′ ″<br>120.21.0 | ° ′ ″<br>19. 0.30 W |
| Sept. 20<br>1834 | h m s<br>8.30. 2 A. M. | ° ′<br>31.30 N. | °<br>55 W. | ° ′<br>31.51 | m s<br>3.48<br>Fast. | h m s<br>4.43.58 A.M. | Jupiter.<br>° ′ ″<br>49. 8.40 NLs | ° ′ ″<br>48.44.44 | ° ′<br>54.58 W |
| Sept. 12<br>1834 | h m s<br>5.13.12 P. M. | ° ′<br>26.30 N. | ° ′<br>25.30 W. | ° ′<br>10.50 | m s<br>0.49<br>Slow. | h m s<br>10.30.30 P.M. | Fomalhaut.<br>° ′ ″<br>41.38.13 N.L. | ° ′ ″<br>41.26.27 | ° ′ ″<br>24.53.45W |

# FIXED STARS.

## PRACTICAL DIRECTIONS FOR KNOWING AND OBSERVING THE PRINCIPAL FIXED STARS.

It is highly important that the young Navigator should become acquainted with the principal fixed stars, so as to be able to have recourse to them with confidence, at any hour of the night, when visible, either for the purpose of taking altitudes, or measuring distances; tables VII. VIII. and IX. it is presumed will afford him a greater degree of certainty in knowing the stars, than any method hitherto described: for having the exact time pointed out to him when they are on the meridian, as well as the approximate altitude, he has only to put the index of his quadrant to that altitude, and direct his sight to the horizon N. or S. as the table directs, and he will perceive the star in the horizon glass, on, or near the horizon, when the meridian altitude may be observed and the star known at the same time. He ought then to compare its situation and bearing with the neighbouring stars, and by so doing will obtain a perfect knowledge of any star in the catalogue.

The best time for making observations on the stars is, when they become perceptible to the naked eye, in the evening twilight, or in the morning, when the horizon is beautifully defined, at which time the latitude may be obtained with accuracy, and at the same time a convenient star may be selected in the E. or W. for the purpose of ascertaining the time and longitude by chronometer, also a lunar observation may be taken at this time with advantage, for the brilliancy of the moon is so much diminished, as to do away the necessity of using a shade, consequently any error arising from the refractive power of the coloured glasses is obviated.

## DESCRIPTION AND USE OF THE STAR TABLES.

Table VII contains the transits, or passage over the meridian of Greenwich, of twenty-four fixed stars, in *apparent time*, for every fifth day, each having its number as given in the catalogue of stars in table VI. These transits are given in *Astronomical time*, and are therefore to be reckoned from the preceding noon, that is, when the time exceeds 12 hours the excess is so much past midnight, and consequently the time in the morning of the following *civil* day, as is used on shore: thus, Jan. the 5th, Star N. 13 *Regulus* will pass the meridian at 14 h. 53 m. which will be at 2 h. 53 m. on the morning of the 6th.

When the time of transit is wanted for any intermediate day, subtract the daily decrease as given in each month, from the next less day given in the table; thus January 13th star N° 13 will pass the meridian at 2 h. 22½ m. in the morning for its transit on the 10th is 14h. 31m. from which subtract 8½m. for two days, and there remains 14h. 22½m. on the 12th which is in the morning of the 13th as above: also subtract half a minute for every 45° of W. lon. but add in E.

Table VIII contains the true meridian altitudes of such of the 24 stars as are above the horizon, for every degree of latitude from the equator to 60° N. and table IX to 60° S.

By means of a good time-keeper, and a knowledge of the principal fixed stars, and a correct mode of observing the altitudes, the exact place of the ship may be known almost every half hour during the night, with as much ease and certainty, as if the observations had been made with the sun.

## PRACTICAL RULES AND EXAMPLES.

To find the time of the passage of any of the 24 fixed stars over the meridian, and its altitude at that time, in any given latitude.

### RULE.

Enter Table VIII, with the day of the month at the top, and the number of the star from Table VII, in the side column, and take out the apparent time of Southing : then enter Table IX, if the latitude be N. but Table X, if it be S. with the number of the star at the top, and the latitude in the side column, and take out the meridian altitude.

### EXAMPLE I.

January the 15th, in latitude 41° N. by account, and longitude 60° W., at what time will Star No. 4, (*Aldebaran,*) come to the meridian, and what will be its altitude at that time?

In Table VIII, under January 15th, and opposite star No. 4, stands 8*h.* 37*m.* from which subtract 1*m.* for 60° of longitude, and the difference, 8*h.* 36*m.* will be the apparent time of the star's passing the meridian of the ship.

In Table IX, under Star No. 4, and opposite the latitude 41° N. is its meridian altitude, 65° 9′ S.

Thus, the index of the quadrant must be fixed at 65° 9′, and a little before 8*h.* 36*m.* the observer has only to turn to the S., as the star bears S. of him, look at the horizon, and he will see its image in the horizon glass, and may then observe its meridian altitude in the same manner as the sun.

### EXAMPLE II.

November the 12th, in latitude 35° 10′ N. and longitude 50° W., being my watch on deck from midnight to 4 o'clock, A. M. I am desirous of knowing what star will suit my purpose for ascertaining the latitude of the ship ; also its meridian altitude.

In Table VIII, I find that stars No. 4, 5, 6, 7, 8, or 9 will do ; I will therefore select No. 9, (*Sirius,*) which on the 10th souths at 15*h.* 35*m.* ; from which subtract 4*m.* for one day, and it will give 15*h.* 31*m.* ; the time of transit on the 11th answering to the 12th at 3*h.* 31*m.* A. M. Subtract one minute for longitude and it will give 3*h.* 30*m.* ; the apparent time on the morning of the given day. In Table X, the meridian altitude is 38° 31′ S.

## TO FIND THE LATITUDE BY MERIDIAN ALTITUDES OF THE STARS.

January the 15th, 1824, the meridian altitude of the star Aldebaran was observed to be 65° 16′ S. : required, the latitude in

| | |
|---|---|
| ✱'s observed altitude, - - - - - | 65° 16′ S. |
| Dip. and refraction, - - - - - | — 4 |
| ✱'s true altitude, - - - - - - - | 65. 12 |
| Subtract from, - - - - - - - - | 90. 00 |
| ✱'s Zenith distance, - - - - - | 24. 48 N. |
| ✱'s declination, - - - - - - - - | 16. 9 N. |
| *Latitude in* - - - - - - - - - | 40. 57 N. |

November the 15th, 1824, the meridian altitude of the star Sirius was observed to be 38° 37′ S. What is the latitude in?

| | |
|---|---|
| ✱'s observed altitude, - - - - - | 38° 37′ S. |
| Dip. and refraction, - - - - - - | — 5 |
| ✱'s true altitude, - - - - - - - | 38. 32 |
| Subtract from, - - - - - - - - | 90. 00 |
| ✱'s Zenith distance, - - - - - | 51. 28 N. |
| ✱'s declination, - - - - - - - - | 16. 29 S. |
| *Latitude in* - - - - - - - - - | 34. 59 N. |

## TO FIND THE LATITUDE BY THE NORTH POLAR STAR

The elevation of the celestial pole above the horizon of any place is equal to the latitude; therefore if a bright star was at the celestial pole, its true altitude would be the latitude; but as there is no star of any considerable magnitude nearer the celestial pole than Alruccabah, in the tail of the little bear commonly called the Polar Star, it is frequently used for the purpose of finding the latitude in the northern hemisphere.

The Polar Star is of great importance in finding the latitude, for it frequently happens that the sun is obscured for several days when on the meridian, during which time a careful observer may find his latitude by an altitude of the star taken at any hour of the night, or rather during the morning or evening twilight; and when the apparent time at the ship is known within a few minutes of the truth, the latitude resulting from this method will, generally, be as near the truth as the common purposes of navigation require.

### RULE.

To the *astronomical* time of Observation, add the sun's right ascension from the N. A. or from Table VI. B. and the sum (rejecting 24 hours when it exceeds that quantity) will be the right ascension of the meridian. From the ✱'s observed altitude subtract the dip and refraction, and the difference will be the true altitude, then enter Table VI. with the right ascension of the meridian and take out the corresponding correction, which apply to the ✱'s true altitude as the table directs, and the sum or difference will be the latitude in.

### EXAMPLE.

March the 9th, 1826, at 4*h.* 30*m.* A. M. the observed altitude of the Pole Star was 40° 20′; reouired the latitude in.

| | | | |
|---|---|---|---|
| Time of Observation, | 16*h.* 30*m.* | ✱'s Observed Altitude, | 40° 20′ |
| ✱'s Right Ascension, | 23. 17 | Dip. 4′ and refraction 1′ | — 5 |
| Sum, - - - - - | 39. 47 | ✱'s True Altitude, | 40. 15 |
| Subtract, - - - | 24. 00 | Cor. from Table VI. - | 1. 12 |
| Right asc. of meridian, | 15. 47 | *Latitude* - - - - | 41. 27 N. |

## A NEW AND ACCURATE METHOD
### OF CALCULATING THE
# LATITUDE FROM TWO ALTITUDES
### OF THE SUN, OR A STAR, OBSERVED ON THE SAME DAY,
### AND THE TIME ELAPSED BETWEEN THE OBSERVATIONS,
### WITHOUT AN ASSUMED LATITUDE.

### REMARK.

It seldom happens at sea that the two altitudes are taken at the same place, therefore the first altitude must be reduced to what it would be, if observed at the second station, at the same instant of time that it was observed at the first, by the following

### RULE.

At the time of Observing the first altitude, take the bearing of the sun or star by compass; find the angle or number of points contained between this bearing and the ship's course by compass between the observations corrected for leeway, if necessary; with this angle enter the traverse table as a course, if it be less than 8 points; but if it be more than 8 points, subtract it from 16 points, and enter the traverse table with the difference as a course, and take out the difference of latitude answering to the distance sailed between the observations. When the angle is less than 8 points, the difference of latitude thus found must be *added* to the first true altitude, but when it is more than 8 points, it must be *subtracted* from it. This corrected altitude is to be used with the second true altitude in the calculation, and the latitude deduced, will be at the second station, which may be reduced to noon by the course and distance sailed.

***Note.*—If the angle be 8 points, the correction for change of station is *nothing*.**

**If the ship sails directly towards the sun, the whole distance sailed, must be *added* to the first true altitude.**

**If the ship sails directly from the sun, the whole distance sailed, must be *subtracted* from the first true altitude.**

### RULE TO CALCULATE THE LATITUDE.

Call the sun or star's corrected declination D, half the elapsed time turned into degrees T, half the sum of the altitudes H, and half their difference *h*.

Put the sine of T, and the co-sine of D, in the first column, and the sine of D, in the second.

Add together sine T, and co-sine D, and the sum will be sine A, put the corresponding secant in the second column, and the co-secant in the third.

Add together sine D, and secant A, in the second column, and the sum will be the co-sine of arch X, which will be more than 90° when the latitude and declination are of different names, but less than 90° when they are of the same name.

Bring down secant A, in the second column, and put sine H, in the second column, and its co-sine in the third, also co-sine *h* in the second, and its sine in the third.

Add together co-secant A, co-sine H, and sine *h* in the third column, and the sum will be sine B, put the corresponding secant in the second column, and the co-sine in the third.

Add together secant A, sine H, co-sine *h*, and secant B, in the second column, and the sum will be the co-sine of arch Y.

When the latitude is N. and the sun bears S. when on the meridian, or when the latitude is S. and the sun bears N. the difference between these two arches will be arch Z, but when the latitude is less than the declination and of the same name, the sum of these two arches will be arch Z.

Add together co-sine B, and the co-sine of arch Z, in the third column, and the sum will be the sine of the latitude.

***Note.*—When the latitude and declination are of the same name, and nearly equal, it is doubtful whether arches X and Y, are to be added or subtracted; therefore the latitude may be computed on both suppositions, and one of the results will be the true latitude, and some circumstances generally occur to decide which is the proper one.**

## EXAMPLES.

February the 1st, 1826, being at sea in North latitude, and longitude by account 25° W. at 9*h*. 58*m*. 5*s*. A. M. the sun's observed altitude was 28° 10′ bearing at the same time S. E. by E. by compass, and at 11*h*. 47*m*. 10*s*. A. M. the observed altitude was 38° 36′ the ship's course between the observations was S. by E. sailing at the rate of 7 knots an hour: required the latitude of the ship at the place where the second observation was taken.

### PREPARATION.

| | | | |
|---|---|---|---|
| **Time of 1st Obs.** | **9*h*.** | **58*m*.** | **5*s*.** |
| **Time of 2d Obs.** | **11.** | **47.** | **10** |
| **Elapsed time, - -** | **1.** | **49.** | **5** |
| **Half do. - - -** | | **54.** | **32** |
| **Equal to - - -** | **13°** | **38′** | **T.** |

**The difference between the sun's bearing and the ship's course is 4 points, and the distance sailed between the observations is 12 miles; enter the traverse table with 4 points as a course, and 12 miles in a distance column, and the corresponding number in the latitude column is 8 miles, to be *added* to the first true altitude.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ☼'s 1st Obs. Alt. | 28°. 10′ | ☼'s 2nd Ob. Alt. | 38°. 36′ | 1st Alt. | 28°. 28′ | ☼'s Dec. | 17°. 9′. 33″ S. |
| semid. and dip | + 12 | semid. and dip | + 12 | 2nd do. | 38. 47 | cor. | + 27 |
| ☼'s App. Alt. | 28. 22 | ☼'s App. Alt. | 38. 48 | Sum - | 67. 15 | cor. dec. | 17. 10. 00 D. |
| refraction | — 2 | refraction | — 1 | | | | |
| | | | | Half - | 33. 37 H. | | |
| ☼'s True Alt. | 28. 20 | ☼'s True Alt. | 38. 47 | | | | |
| cor. for station | ☼ 8 | | | Diff. | 10. 19 | | |
| ☼'s correct Alt. | 28. 28 | | | Half dif. | 5. 9*h*. | | |

## CALCULATION OF THE LATITUDE.

| | | | | | |
|---|---|---|---|---|---|
| Sine T. | 9. 37237 | | | | |
| Cosine D. | 9. 98021 | Sine D | 9. 47005 | | |
| Sine A. - | 9. 35258 | Sec. A. | 01131 | Cosec. A. | 64737 |
| Arch X. | 107°. 38′ | Cosine | 9. 48136 | | |
| | | Sec. A. | 01131 | | |
| | | Sine H. | 9. 74322 | Cosine H. | 9. 92052 |
| | | Cosine *h*. | 9. 99824 | Sine *h*. | 8. 95310 |
| | | Sec. B. | 02534 | Sine B. | 9. 52099 |
| Arch Y. | 53. 8 | Cosine | 9. 77811 | Cosine B. | 9. 97466 |
| Arch Z. | 54. 30 | | | Cosine | 9. 76395 |
| | | *Latitude* | 33°, 13′ N. | Sine | 9. 73861 |

## QUESTIONS FOR EXERCISE IN THE DOUBLE ALTITUDES.

| Date Civil Time | Lat. by Act. | Long. by acct. | Time of Obs. | Obs. Alt. | Bear of ☼ at first Obs. | Course and Dist. in the interval. | Answer Latitude. |
|---|---|---|---|---|---|---|---|
| | ° ′ | ° | h. m. s. | ° ′ | | | ° ′ |
| May 13. 1826. | 51.10 N. | 20 W. | 9. 52. 14 A. M.<br>2. 12. 20 P. M. | 47. 26<br>48. 13 | S. by E. | S. S. E. 4 miles an hour. | 51.27 N. |
| Feb. 11. 1826. | 59.30 N. | 25 W. | 1. 30. 20 P. M.<br>3. 33. 25 P. M. | 15. 17<br>6. 30 | S. W. | North 10 miles an hour. | 59.13 N. |
| June 8. 1826. | 6.40 N. | 45 W. | 7. 30. 10 A. M.<br>10. 36. 40 A. M. | 22. 18<br>63. 28 | N. E. | N. W. 5 miles an hour. | 6.51 N. |
| Mar. 22. 1826. | 1.40 N. | 30 W. | 10. 24. 5 A. M,<br>11. 20. 8 A. M. | 64. 47<br>78. 45 | E. ½ S. | S. S. E. 3½ miles an hour. | 2.6 N. |
| Aug. 29. 1826. | 11.20 S. | 85 E. | 11. 13. 30 A. M.<br>1. 15. 20 P. M. | 66. 10<br>62. 1 | N. W. ½ W | S. W. by W. 5 miles an hour. | 11. 19 S. |
| July 24. 1826. | 10.5 N. | 78 E. | 11. 19. 30 A. M.<br>5. 39. 30. P. M. | 75. 55<br>7. 51 | N. N. E. | East 1½ miles an hour. | 10. 2. N. |

In the above examples the declination has been corrected for the middle time between the observation, also for the longitude.

The declination for these examples may be taken from 1834.

# TABLE I.

## The Effect of Refraction on the Distance between the Moon and the Sun, Fixed Star, or Planet.

| Less Altitude. | Greater Altitude. | APPARENT DISTANCE. | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 55° | 60° | 65° | 70° | 75° | 80° | 85° | 90° | 95° | 100° | 105° | 110° | 115° | 120° |
| ° | ° | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ |
| 10 | 10 | 0.19 | 0.23 | 0.30 | 0.34 | 0.40 | 0.45 | 0.53 | 0.58 | 1. 4 | 1.10 | 1.18 | 1.26 | 1.34 | 1.42 | 1.52 | 2. 2 | 2.14 | 2.26 | 2.40 | 2.53 | 3 14 |
| | 15 | 0.45 | 0.45 | 0.46 | 0.50 | 0.54 | 0.59 | 1. 6 | 1. 9 | 1.14 | 1.20 | 1.27 | 1.35 | 1.42 | 1.51 | 2. 0 | 2.12 | 2.22 | 2.35 | 2.50 | 3. 6 | 3.24 |
| | 20 | 1.30 | 1.25 | 1.21 | 1.20 | 1.20 | 1.22 | 1.26 | 1.30 | 1.34 | 1.40 | 1.46 | 1.53 | 2. 0 | 2. 8 | 2.17 | 2.29 | 2.39 | 2.53 | 3. 8 | 3.24 | 3 44 |
| | 25 | 2.29 | 2.13 | 2. 1 | 1.55 | 1.50 | 1 51 | 1.52 | 1.55 | 1.57 | 2. 2 | 2. 7 | 2.14 | 2.21 | 2.29 | 2.39 | 2.49 | 3. 0 | 3.14 | 3 29 | 3.47 | 4. 9 |
| | 30 | 3.37 | 3. 2 | 2.41 | 2.33 | 2.25 | 2.21 | 2.20 | 2.20 | 2.21 | 2.26 | 2.30 | 2.37 | 2 42 | 2.50 | 2.59 | 3.10 | 3.21 | 3.36 | 3.52 | 4.10 | 4.31 |
| | 35 | . | 3.54 | 3.25 | 3. 5 | 2.56 | 2.50 | 2.49 | 2.47 | 2.45 | 2.47 | 2.52 | 2.58 | 3. 3 | 3.12 | 3.20 | 3.32 | 3.42 | 3.59 | 4 15 | 4.32 | 4.55 |
| | 40 | . | . | 4. 7 | 3.43 | 3.29 | 3.19 | 3.15 | 3.10 | 3.10 | 3.10 | 3.15 | 3.19 | 3.24 | 3.32 | 3.40 | 3.53 | 4. 3 | 4.18 | 4.37 | 4.56 | 5.20 |
| | 45 | . | . | . | 4.18 | 3.59 | 3.51 | 3.41 | 3.36 | 3.31 | 3.32 | 3.34 | 3.39 | 3.43 | 3.51 | 3.59 | 4.12 | 4.23 | 4.38 | 4.58 | 5.16 | 5.44 |
| | 50 | . | . | . | . | 4.27 | 4.12 | 4. 2 | 3.59 | 3.51 | 3.51 | 3.54 | 3.57 | 4. 0 | 4. 9 | 4.16 | 4.30 | 4.40 | 4.56 | 5.14 | 5.36 | 6. 3 |
| | 55 | . | . | . | . | . | 4.35 | 4.25 | 4.20 | 4.10 | 4. 9 | 4.11 | 4.15 | 4.17 | 4.25 | 4.32 | 4.45 | 4 59 | 5.13 | 5.31 | 5.55 | |
| | 60 | . | . | . | . | . | . | 4.42 | 4.32 | 4.29 | 4.25 | 4.26 | 4.29 | 4.31 | 4.38 | 4.47 | 4.59 | 5.10 | 5.28 | 5.48 | | |
| | 65 | . | . | . | . | . | . | . | 4.48 | 4.41 | 4.39 | 4.39 | 4.43 | 4.45 | 4.51 | 5. 0 | 5.12 | 5.25 | 5.42 | | | |
| | 70 | . | . | . | . | . | . | . | . | 4.54 | 4.50 | 4.49 | 4.52 | 4.55 | 5. 1 | 5.10 | 5.22 | 5.36 | | | | |
| | 75 | . | . | . | . | . | . | . | . | . | 5. 0 | 4.56 | 5. 0 | 5. 1 | 5. 8 | 5.18 | 5.30 | | | | | |
| | 80 | . | . | . | . | . | . | . | . | . | . | 5. 5 | 5. 6 | 5. 9 | 5.16 | 5.25 | | | | | | |
| 11 | 11 | 0.19 | 0.24 | 0.29 | 0.34 | 0.40 | 0.46 | 0.53 | 0.58 | 1. 4 | 1.10 | 1.18 | 1.26 | 1.34 | 1.42 | 1.52 | 2. 2 | 2.14 | 2.26 | 2.40 | 2.53 | 3.14 |
| | 15 | 0.32 | 0.36 | 0.39 | 0.44 | 0.49 | 0.54 | 1. 2 | 1. 5 | 1.11 | 1.16 | 1.24 | 1.32 | 1.39 | 1.48 | 1.57 | 2. 9 | 2.19 | 2.32 | 2.45 | 3. 2 | 3.20 |
| | 20 | 1.14 | 1. 9 | 1. 8 | 1. 9 | 1.10 | 1.13 | 1.19 | 1.22 | 1.27 | 1.33 | 1.40 | 1.47 | 1.53 | 2. 3 | 2.11 | 2.23 | 2.33 | 2.47 | 3. 1 | 3.17 | 3 37 |
| | 25 | 2. 7 | 1.51 | 1.42 | 1.40 | 1.38 | 1.39 | 1.41 | 1.43 | 1.48 | 1.52 | 1.58 | 2. 5 | 2 12 | 2.20 | 2.29 | 2.40 | 2.51 | 3. 5 | 3.20 | 3 37 | 3.58 |
| | 30 | 3. 1 | 2.35 | 2.20 | 2.12 | 2. 7 | 2. 5 | 2. 6 | 2. 7 | 2.10 | 2.14 | 2.18 | 2.25 | 2 31 | 2.40 | 2.48 | 3. 0 | 3.10 | 3.25 | 3.40 | 3.58 | 4 20 |
| | 35 | 3.52 | 3.19 | 2.59 | 2.45 | 2.35 | 2.31 | 2.31 | 2.31 | 2.30 | 2.33 | 2.38 | 2.44 | 2 50 | 2.59 | 3. 7 | 3.18 | 3.28 | 3.45 | 4. 0 | 4.19 | 4.41 |
| | 40 | . | 4. 0 | 3.35 | 3.16 | 3. 3 | 2.59 | 2.55 | 2.51 | 2.51 | 2.53 | 2.58 | 3. 2 | 3.10 | 3.17 | 3.25 | 3.37 | 3.48 | 4. 3 | 4.20 | 4.40 | 5. 2 |
| | 45 | . | . | 4. 7 | 3.46 | 3.32 | 3.21 | 3.16 | 3.15 | 3.13 | 3.13 | 3.17 | 3.21 | 3.27 | 3.35 | 3.43 | 3.56 | 4. 6 | 4.21 | 4.39 | 4.56 | 5.25 |
| | 50 | . | . | . | 4.12 | 3.59 | 3.44 | 3.40 | 3.35 | 3.30 | 3.31 | 3.34 | 3.37 | 3.42 | 3 51 | 3.59 | 4.11 | 4.21 | 4 37 | 4.55 | 5.14 | 5.39 |
| | 55 | . | . | . | . | 4.17 | 4. 5 | 3.59 | 3.52 | 3.47 | 3.47 | 3.50 | 3.53 | 3.57 | 4. 5 | 4.12 | 4.25 | 4.36 | 4.47 | 5.11 | 5.31 | |
| | 60 | | . | . | . | . | 4.21 | 4.13 | 4. 9 | 4. 1 | 4. 0 | 4. 3 | 4. 7 | 4.10 | 4.19 | 4.26 | 4.39 | 4.50 | 5. 6 | 5.23 | | |
| | 65 | . | . | . | . | . | . | 4.26 | 4.22 | 4.15 | 4.12 | 4.15 | 4.19 | 4.21 | 4.29 | 4.38 | 4.50 | 5. 3 | 5.16 | | | |
| | 70 | . | . | . | . | . | | . | 4.29 | 4.27 | 4.23 | 4.24 | 4.27 | 4.31 | 4.39 | 4.47 | 4.59 | 5.10 | | | | |
| | 75 | . | . | . | . | . | . | . | . | 4.34 | 4 32 | 4.30 | 4.34 | 4.36 | 4.45 | 4.53 | 5. 4 | | | | | |
| | 80 | . | . | . | . | . | . | . | . | . | 4.36 | 4.38 | 4.40 | 4.42 | 4.50 | 4.59 | | | | | | |
| 12 | 12 | 0.19 | 0.24 | 0.29 | 0.34 | 0.40 | 0.45 | 0.53 | 0.58 | 1. 4 | 1.10 | 1.18 | 1.26 | 1.34 | 1.42 | 1.52 | 2. 2 | 2.14 | 2.26 | 2.40 | 2.53 | 3.14 |
| | 15 | 0.26 | 0.30 | 0.35 | 0.40 | 0.45 | 0.51 | 0.58 | 1. 3 | 1. 8 | 1.14 | 1.22 | 1.30 | 1.37 | 1.46 | 1.55 | 2. 6 | 2.17 | 2.29 | 2.44 | 3. 0 | 3.18 |
| | 20 | 0.58 | 0.57 | 0.58 | 0.59 | 1. 2 | 1. 6 | 1.13 | 1.16 | 1.21 | 1.27 | 1.34 | 1.41 | 1.48 | 1.57 | 2. 6 | 2.18 | 2.28 | 2.42 | 2.56 | 3.12 | 3.32 |
| | 25 | 1.43 | 1.33 | 1.28 | 1.26 | 1.25 | 1.28 | 1.32 | 1.34 | 1.38 | 1.44 | 1.51 | 1 57 | 2. 4 | 2.13 | 2.22 | 2.33 | 2.44 | 2.57 | 3.12 | 3.29 | 3.49 |
| | 30 | 2.32 | 2.11 | 2. 0 | 1.56 | 1.51 | 1.51 | 1.55 | 1.56 | 1.58 | 2. 3 | 2. 8 | 2.15 | 2.21 | 2.30 | 2.38 | 2·50 | 3. 1 | 3.14 | 3.30 | 3.48 | 4. 9 |
| | 35 | 3.19 | 2.50 | 2.37 | 2.26 | 2.15 | 2.15 | 2.16 | 2.17 | 2.18 | 2.19 | 2.26 | 2.32 | 2.39 | 2.46 | 2.56 | 3. 6 | 3.17 | 3.32 | 3.48 | 4. 6 | 4.28 |
| | 40 | . | 3.29 | 3. 9 | 2.52 | 2.43 | 2.39 | 2.38 | 2.35 | 2.38 | 2.39 | 2.44 | 2.49 | 2.56 | 3. 3 | 3.12 | 3.23 | 3.35 | 3.49 | 4. 7 | 4.25 | 4.47 |
| | 45 | . | . | 3.31 | 3.20 | 3. 7 | 3. 1 | 2.58 | 2.57 | 2.56 | 2.56 | 3. 0 | 3. 5 | 3.12 | 3.20 | 3.28 | 3.40 | 3.51 | 4. 5 | 4.23 | 4.43 | 5. 7 |
| | 50 | . | . | . | 3.43 | 3.31 | 3.21 | 3.16 | 3.14 | 3.12 | 3.12 | 3.18 | 3.20 | 3.27 | 3.35 | 3.43 | 3.55 | 4. 6 | 4.21 | 4.38 | 4.57 | 5.21 |
| | 55 | . | . | . | . | 3.50 | 3.41 | 3.35 | 3.31 | 3.27 | 3.27 | 3.31 | 3.34 | 3 40 | 3.47 | 3.56 | 4. 7 | 4.20 | 4.34 | 4.52 | 5.12 | |
| | 60 | . | . | . | . | . | 3.55 | 3.49 | 3.45 | 3.40 | 3.40 | 3.44 | 3.45 | 3.50 | 3.57 | 4. 8 | 4.17 | 4.30 | 4.47 | 5. 4 | | |
| | 65 | . | . | . | . | . | . | 4. 0 | 3.58 | 3.52 | 3.51 | 3.54 | 3.57 | 4. 1 | 4. 8 | 4.17 | 4.29 | 4.41 | 4.56 | | | |
| | 70 | . | . | . | . | . | . | . | 4. 4 | 4. 1 | 4. 0 | 4. 3 | 4. 5 | 4. 9 | 4.18 | 4.26 | 4.38 | 4.49 | | | | |
| | 75 | . | . | . | . | . | . | . | . | 4. 9 | 4. 7 | 4.10 | 4.12 | 4.16 | 4.23 | 4.32 | 4.43 | | | | | |
| | 80 | . | . | . | . | . | . | . | . | . | 4.13 | 4.14 | 4.17 | 4.21 | 4.28 | 4.37 | | | | | | |
| 13 | 13 | 0.19 | 0.24 | 0.29 | 0.34 | 0.40 | 0.45 | 0.53 | 0.58 | 1. 4 | 1.10 | 1.18 | 1.26 | 1.34 | 1.42 | 1.52 | 2. 2 | 2.14 | 2.26 | 2.40 | 2.53 | 3.14 |
| | 15 | 0.22 | 0.27 | 0.32 | 0.38 | 0.43 | 0.48 | 0.56 | 1. 1 | 1. 6 | 1.12 | 1.20 | 1.28 | 1.36 | 1.44 | 1.54 | 2. 4 | 2.15 | 2.28 | 2.42 | 2.58 | 3.16 |
| | 20 | 0 45 | 0.45 | 0.49 | 0.51 | 0.55 | 1. 0 | 1. 8 | 1.10 | 1.16 | 1.22 | 1.29 | 1.37 | 1.45 | 1.53 | 2. 2 | 2.14 | 2.25 | 2.39 | 2.51 | 3. 7 | 3.27 |
| | 25 | 1.23 | 1.16 | 1.15 | 1.14 | 1.15 | 1.18 | 1.24 | 1.25 | 1.31 | 1.37 | 1.44 | 1.51 | 1.58 | 2. 6 | 2.16 | 2.26 | 2 37 | 2.51 | 3. 6 | 3.22 | 3.41 |
| | 30 | 2.10 | 1.50 | 1.43 | 1.40 | 1.39 | 1.40 | 1.43 | 1.45 | 1.49 | 1.53 | 1.59 | 2. 6 | 2.13 | 2.20 | 2.30 | 2.41 | 2.52 | 3. 5 | 3.20 | 3.39 | 3.58 |
| | 35 | 2.53 | 2.26 | 2.16 | 2.10 | 2. 0 | 2. 1 | 2. 3 | 2. 4 | 2. 7 | 2. 8 | 2.15 | 2.22 | 2.29 | 2.36 | 2.46 | 2.57 | 3. 7 | 3.22 | 3.37 | 3.56 | 4.16 |
| | 40 | . | 3. 4 | 2.45 | 2.33 | 2.25 | 2.22 | 2.22 | 2.20 | 2.24 | 2.25 | 2.31 | 2.37 | 2.44 | 2.51 | 3. 0 | 3.11 | 3.23 | 3.37 | 3.53 | 4.12 | 4.34 |
| | 45 | . | . | 3.13 | 2.57 | 2.47 | 2.43 | 2.41 | 2.40 | 2.41 | 2.41 | 2.47 | 2.52 | 2.59 | 3. 6 | 3.16 | 3.27 | 3.38 | 3.52 | 4. 9 | 4.23 | 4.51 |
| | 50 | . | . | . | 3.21 | 3. 9 | 3. 0 | 2.59 | 2.57 | 2.56 | 2.57 | 3. 0 | 3. 4 | 3.11 | 3.19 | 3.29 | 3.40 | 3.51 | 4. 5 | 4.21 | 4.42 | 5. 5 |
| | 55 | . | . | . | . | 3.27 | 3.19 | 3.13 | 3.10 | 3.10 | 3.10 | 3.15 | 3.19 | 3.24 | 3.31 | 3.41 | 3.51 | 4. 3 | 4.18 | 4.36 | 4.55 | |
| | 60 | . | . | . | . | . | 3.33 | 3.26 | 3.23 | 3.21 | 3.20 | 3.26 | 3 29 | 3.35 | 3.40 | 3.51 | 4. 1 | 4.14 | 4.29 | 4.47 | | |
| | 65 | . | . | . | . | . | . | 3.40 | 3.36 | 3.32 | 3.31 | 3.35 | 3.40 | 3.45 | 3.50 | 4. 0 | 4.10 | 4.24 | 4.39 | | | |
| | 70 | . | . | . | . | . | . | . | 3.44 | 3.40 | 3.40 | 3.42 | 3.46 | 3.51 | 3.59 | 4. 8 | 4.19 | 4.32 | | | | |
| | 75 | | . | . | . | . | . | . | . | 3.48 | 3.47 | 3.49 | 3.52 | 3.56 | 4. 3 | 4.14 | 4.25 | | | | | |
| | 80 | . | . | . | . | . | . | . | . | . | 3.52 | 3.54 | 3.58 | 4. 2 | 4.10 | 4.19 | | | | | | |

# TABLE I.

## The Effect of Refraction on the Distance between the Moon and the Sun, Fixed Star, or Planet.

| Less Altitude. | Greater Altitude. | APPARENT DISTANCE. | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 55° | 60° | 65° | 70° | 75° | 80° | 85° | 90° | 95° | 100° | 105° | 110° | 115° | 120° |
| ° | ° | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ |
| 14 | 14 | 0.19 | 0.24 | 0.29 | 0.36 | 0.40 | 0.46 | 0.54 | 0.59 | 1. 5 | 1.11 | 1.19 | 1.27 | 1.34 | 1.43 | 1.53 | 2. 3 | 2.14 | 2.27 | 2.41 | 2.57 | 3.15 |
| | 15 | 0.20 | 0.25 | 0.30 | 0.36 | 0.42 | 0.47 | 0.55 | 1. 0 | 1. 5 | 1.11 | 1.20 | 1.28 | 1.34 | 1.43 | 1.53 | 2. 3 | 2.14 | 2.27 | 2.41 | 2.57 | 3.15 |
| | 20 | 0.36 | 0.38 | 0.43 | 0.47 | 0.50 | 0.56 | 1. 1 | 1. 6 | 1.13 | 1.19 | 1.26 | 1.34 | 1.42 | 1.50 | 1.58 | 2.11 | 2.22 | 2.34 | 2.48 | 3. 5 | 3.24 |
| | 25 | 1. 8 | 1. 4 | 1. 5 | 1. 6 | 1. 7 | 1.10 | 1.17 | 1.19 | 1.25 | 1.31 | 1.38 | 1.46 | 1.53 | 2. 1 | 2.10 | 2.22 | 2.32 | 2.46 | 3. 0 | 3.16 | 3.36 |
| | 30 | 1.48 | 1.35 | 1.30 | 1.29 | 1.29 | 1.29 | 1.34 | 1.36 | 1.41 | 1.46 | 1.52 | 1.59 | 2. 6 | 2.14 | 2.24 | 2.34 | 2.45 | 2.58 | 3.14 | 3.31 | 3.50 |
| | 35 | 2.29 | 2. 7 | 1.58 | 1.53 | 1.48 | 1.49 | 1.52 | 1.54 | 1.57 | 2. 0 | 2. 7 | 2.13 | 2.20 | 2.28 | 2.38 | 2.48 | 2.59 | 3.13 | 3.28 | 3.47 | 4. 6 |
| | 40 | . | 2.41 | 2.26 | 2.17 | 2.10 | 2. 8 | 2. 9 | 2. 9 | 2.13 | 2.14 | 2.21 | 2.27 | 2.34 | 2.41 | 2.50 | 3. 1 | 3.13 | 3.27 | 3.43 | 4. 1 | 4.23 |
| | 45 | . | . | 2.52 | 2.41 | 2.29 | 2.27 | 2.26 | 2.26 | 2.28 | 2.29 | 2.35 | 2.40 | 2.48 | 2.55 | 3. 5 | 3.15 | 3.26 | 3.40 | 3.57 | 4.16 | 4.39 |
| | 50 | . | . | . | 3. 1 | 2.50 | 2.44 | 2.41 | 2.40 | 2.41 | 2.42 | 2.47 | 2.51 | 3. 0 | 3. 7 | 3.16 | 3.28 | 3.39 | 3.54 | 4.10 | 4.29 | 4.51 |
| | 55 | . | . | . | . | 3. 7 | 2.59 | 2.56 | 2.55 | 2.55 | 2.56 | 3. 0 | 3. 5 | 3.11 | 3.18 | 3.27 | 3.38 | 3.50 | 4. 4 | 4.21 | 4.42 | |
| | 60 | . | . | . | . | . | 3.14 | 3. 9 | 3. 6 | 3. 5 | 3. 6 | 3.11 | 3.14 | 3.20 | 3.27 | 3.37 | 3.48 | 4. 0 | 4.16 | 4.32 | | |
| | 65 | . | . | . | . | . | . | 3.22 | 3.18 | 3.15 | 3.17 | 3.20 | 3.25 | 3.30 | 3.36 | 3.46 | 3.57 | 4.10 | 4.24 | | | |
| | 70 | . | . | . | . | . | . | . | 3.25 | 3.21 | 3.23 | 3.26 | 3.31 | 3.36 | 3.44 | 3.53 | 4. 4 | 4.17 | | | | |
| | 75 | . | . | . | . | . | . | . | . | 3.30 | 3.30 | 3.32 | 3.37 | 3.42 | 3.48 | 3.59 | 4.10 | | | | | |
| | 80 | . | . | . | . | . | . | . | . | . | 3.35 | 3.38 | 3.41 | 3.46 | 3.53 | 4. 3 | | | | | | |
| 15 | 15 | 0.19 | 0.24 | 0.29 | 0.36 | 0.40 | 0.46 | 0.54 | 0.59 | 1. 5 | 1.11 | 1.19 | 1.27 | 1.34 | 1.43 | 1.53 | 2. 3 | 2.14 | 2.27 | 2.41 | 2.57 | 3.15 |
| | 20 | 0.28 | 0.33 | 0.38 | 0.43 | 0.47 | 0.53 | 1. 0 | 1. 4 | 1.10 | 1.16 | 1.24 | 1.32 | 1.40 | 1.48 | 1.57 | 2. 9 | 2.20 | 2.32 | 2.46 | 3. 2 | 3.20 |
| | 25 | 0.54 | 0.55 | 0.56 | 0.59 | 1. 0 | 1. 3 | 1.12 | 1.14 | 1.21 | 1.27 | 1.33 | 1.41 | 1.48 | 1.58 | 2. 6 | 2.18 | 2.28 | 2.41 | 2.56 | 3.12 | 3.31 |
| | 30 | 1.30 | 1.21 | 1.19 | 1.20 | 1.20 | 1.21 | 1.26 | 1.29 | 1.34 | 1.40 | 1.45 | 1.53 | 2. 0 | 2. [illegible] | 2.18 | 2.29 | 2.39 | 2.52 | 3. 8 | 3.25 | 3.44 |
| | 35 | 2. 9 | 1.51 | 1.44 | 1.41 | 1.38 | 1.39 | 1.42 | 1.45 | 1.33 | 1.52 | 1.59 | 2. 6 | 2.12 | 2.20 | 2.30 | 2.41 | 2.51 | 3. 5 | 3.21 | 3.39 | 3.58 |
| | 40 | . | 2.22 | 2. 8 | 2. 1 | 1.58 | 1.57 | 1.59 | 1.59 | 2. 2 | 2. 6 | 2.11 | 2.19 | 2.25 | 2.33 | 2.42 | 2.54 | 3. 4 | 3.18 | 3.35 | 3.53 | 4.14 |
| | 45 | . | . | 2.33 | 2.23 | 2.15 | 2.12 | 2.13 | 2.14 | 2.17 | 2.19 | 2.24 | 2.31 | 2.38 | 2.45 | 2.55 | 3. 6 | 3.17 | 3.30 | 3.47 | 4. 4 | 4.27 |
| | 50 | . | . | . | 2.42 | 2.32 | 2.29 | 2.28 | 2.29 | 2.29 | 2.31 | 2.36 | 2.41 | 2.49 | 2.57 | 3. 6 | 3.17 | 3.28 | 3.43 | 3.59 | 4.18 | |
| | 55 | . | . | . | . | 2.50 | 2.43 | 2.41 | 2.40 | 2.40 | 2.44 | 2.49 | 2.53 | 2.59 | 3. 7 | 3.16 | 3.27 | 3.39 | 3.53 | 4.10 | | |
| | 60 | . | . | . | . | . | 2.57 | 2.51 | 2.51 | 2.51 | 2.53 | 2.59 | 3. 1 | 3. 9 | 3.15 | 3.25 | 3.37 | 3.48 | 4. 3 | | | |
| | 65 | . | . | . | . | . | . | 3. 5 | 3. 1 | 3. 1 | 3. 2 | 3. 6 | 3.11 | 3.18 | 3.24 | 3.33 | 3.45 | 3.57 | | | | |
| | 70 | . | . | . | . | . | . | . | 3. 9 | 3. 9 | 3.10 | 3.13 | 3.19 | 3.23 | 3.31 | 3.40 | 3.51 | | | | | |
| | 75 | . | . | . | . | . | . | . | . | 3.15 | 3.15 | 3.19 | 3.23 | 3.28 | 3.37 | 3.45 | | | | | | |
| | 80 | . | . | . | . | . | . | . | . | . | 3.20 | 3.23 | 3.28 | 3.32 | 3.40 | | | | | | | |
| 16 | 16 | 0.19 | 0.24 | 0.29 | 0.36 | 0.40 | 0.46 | 0.54 | 0.59 | 1. 5 | 1.11 | 1.19 | 1.27 | 1.34 | 1.43 | 1.53 | 2. 3 | 2.14 | 2.27 | 2.41 | 2.57 | 3.15 |
| | 20 | 0.24 | 0.29 | 0.34 | 0.40 | 0.44 | 0.51 | 0.58 | 1. 2 | 1. 8 | 1.14 | 1.22 | 1.31 | 1.38 | 1.46 | 1.56 | 2. 7 | 2.18 | 2.30 | 2.44 | 3. 0 | 3.19 |
| | 25 | 0.42 | 0.38 | 0.49 | 0.52 | 0.55 | 0.58 | 1. 8 | 1. 9 | 1.16 | 1.22 | 1.29 | 1.38 | 1.45 | 1.54 | 2. 2 | 2.15 | 2.25 | 2.38 | 2.52 | 3. 8 | 3.27 |
| | 30 | 1.15 | 1. 9 | 1.11 | 1.11 | 1.11 | 1.13 | 1.20 | 1.23 | 1.28 | 1.34 | 1.40 | 1.48 | 1.55 | 1. 2 | 2.13 | 2.24 | 2.34 | 2.47 | 3. 2 | 3.20 | 3.38 |
| | 35 | 1.53 | 1.37 | 1.34 | 1.29 | 1.28 | 1.30 | 1.34 | 1.37 | 1.41 | 1.45 | 1.52 | 1.59 | 2. 6 | 2.14 | 2.24 | 2.35 | 2.45 | 2.59 | 3.14 | 3.32 | 3.51 |
| | 40 | 2.25 | 2. 7 | 1.56 | 1.50 | 1.48 | 1.46 | 1.49 | 1.50 | 1.54 | 1.58 | 2. 3 | 2.11 | 2.18 | 2.25 | 2.35 | 2.46 | 2.57 | 3.11 | 3.27 | 3.45 | 4. 4 |
| | 45 | . | 2.32 | 2.18 | 2.10 | 2. 5 | 2. 1 | 2. 2 | 2. 3 | 2. 7 | 2.10 | 2.15 | 2.23 | 2.29 | 2.37 | 2.46 | 2.58 | 3. 9 | 3.22 | 3.38 | 3.57 | 4.19 |
| | 50 | . | . | 2.38 | 2.28 | 2.21 | 2.16 | 2.15 | 2.16 | 2.18 | 2.21 | 2.26 | 2.32 | 2.39 | 2.48 | 2.56 | 3. 7 | 3.19 | 3.33 | 3.49 | 4. 9 | |
| | 55 | . | . | . | 2.45 | 2.36 | 2.29 | 2.29 | 2.29 | 2.29 | 2.32 | 2.36 | 2.42 | 2.49 | 2.58 | 3. 5 | 3.16 | 3.28 | 3.42 | 3.58 | | |
| | 60 | . | . | . | . | 2.49 | 2.42 | 2.39 | 2.38 | 2.39 | 2.41 | 2.46 | 2.50 | 2.58 | 3. 5 | 3.13 | 3.25 | 3.36 | 3.53 | | | |
| | 65 | . | . | . | . | . | 2.54 | 2.50 | 2.47 | 2.47 | 2.50 | 2.54 | 3. 0 | 3. 6 | 3.13 | 3.21 | 3.33 | 3.46 | | | | |
| | 70 | . | . | . | . | . | . | 3. 0 | 2.56 | 2.56 | 2.58 | 3. 1 | 3. 6 | 3.12 | 3.20 | 3.28 | 3.40 | | | | | |
| | 75 | . | . | . | . | . | . | . | 3. 2 | 3. 2 | 3. 3 | 3. 7 | 3.11 | 3.17 | 3.23 | 3.34 | | | | | | |
| | 80 | . | . | . | . | . | . | . | . | 3. 6 | 3. 7 | 3.11 | 3.15 | 3.21 | 3.28 | | | | | | | |
| 17 | 17 | 0.19 | 0.24 | 0.29 | 0.36 | 0.40 | 0.46 | 0.54 | 0.59 | 1. 5 | 1.11 | 1.19 | 1.27 | 1.34 | 1.43 | 1.53 | 2. 3 | 2.14 | 2.27 | 2.41 | 2.57 | 3.15 |
| | 20 | 0.22 | 0.27 | 0.33 | 0.38 | 0.43 | 0.49 | 0.57 | 1. 1 | 1. 6 | 1.13 | 1.21 | 1.30 | 1.37 | 1.46 | 1.55 | 2. 6 | 2.17 | 2.29 | 2.43 | 3. 0 | 3.18 |
| | 25 | 0.35 | 0.41 | 0.43 | 0.48 | 0.51 | 0.57 | 1. 3 | 1. 7 | 1.13 | 1.20 | 1.26 | 1.36 | 1.43 | 1.52 | 2. 0 | 2.12 | 2.23 | 2.35 | 2.50 | 3. 6 | 3.25 |
| | 30 | 1. 2 | 1. 0 | 1. 1 | 1. 4 | 1. 7 | 1. 8 | 1.14 | 1.19 | 1.23 | 1.30 | 1.36 | 1.44 | 1.50 | 2. 0 | 2. 9 | 2.21 | 2.31 | 2.44 | 2.59 | 3.14 | 3.34 |
| | 35 | 1.34 | 1.26 | 1.21 | 1.20 | 1.20 | 1.22 | 1.28 | 1.32 | 1.36 | 1.40 | 1.47 | 1.55 | 2. 1 | 2. 9 | 2.19 | 2.31 | 2.40 | 2.54 | 3. 9 | 3.26 | 3.46 |
| | 40 | 2. 7 | 1.50 | 1.41 | 1.40 | 1.38 | 1.38 | 1.41 | 1.44 | 1.47 | 1.51 | 1.59 | 2. 5 | 2.11 | 2.20 | 2.29 | 2.40 | 2.51 | 3. 5 | 3.20 | 3.38 | 3.58 |
| | 45 | . | 2.16 | 2. 1 | 1.57 | 1.53 | 1.52 | 1.54 | 1.56 | 1.58 | 2. 3 | 2. 8 | 2.16 | 2.22 | 2.31 | 2.39 | 2.51 | 3. 2 | 3.15 | 3.31 | 3.50 | 4.10 |
| | 50 | . | . | 2.23 | 2.12 | 2. 8 | 2. 4 | 2. 5 | 2. 8 | 2. 9 | 2.14 | 2.19 | 2.26 | 2.31 | 2.40 | 2.49 | 3. 0 | 3.11 | 3.25 | 3.42 | 4. 0 | |
| | 55 | . | . | . | 2.30 | 2.20 | 2.19 | 2.18 | 2.19 | 2.20 | 2.24 | 2.28 | 2.35 | 2.40 | 2.50 | 2.58 | 3. 9 | 3.20 | 3.35 | 3.51 | | |
| | 60 | . | . | . | . | 2.35 | 2.31 | 2.27 | 2.28 | 2.29 | 2.31 | 2.36 | 2.42 | 2.48 | 2.57 | 3. 4 | 3.18 | 3.28 | 3.43 | | | |
| | 65 | . | . | . | . | . | 2.40 | 2.39 | 2.36 | 2.37 | 2.40 | 2.44 | 2.50 | 2.56 | 3. 5 | 3.11 | 3.25 | 3.36 | | | | |
| | 70 | . | . | . | . | . | . | 2.47 | 2.43 | 2.43 | 2.47 | 2.50 | 2.56 | 3. 1 | 3.10 | 3.18 | 3.30 | | | | | |
| | 75 | . | . | . | . | . | . | . | 2.49 | 2.50 | 2.52 | 2.55 | 3. 0 | 3. 6 | 3.14 | 3.23 | | | | | | |
| | 80 | . | . | . | . | . | . | . | . | 2.54 | 2.55 | 2.59 | 3. 4 | 3.10 | 3.18 | | | | | | | |

# TABLE I.

## The Effect of Refraction on the Distance between the Moon and the Sun, Fixed Star, or Planet.

| Less Altitude. | Greater Altitude. | APPARENT DISTANCE. | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 55° | 60° | 65° | 70° | 75° | 80° | 85° | 90° | 95° | 100° | 105° | 110° | 115° | 120° |
| ° | ° | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ |
| 18 | 18 | 0.19 | 0.24 | 0.30 | 0.36 | 0.40 | 0.47 | 0.54 | 0.59 | 1. 5 | 1.12 | 1·19 | 1.27 | 1.35 | 1.43 | 1.53 | 2. 3 | 2.15 | 2.27 | 2.41 | 2.58 | 3.15 |
| | 20 | 0.21 | 0.26 | 0.30 | 0.37 | 0.42 | 0.48 | 0.56 | 1. 0 | 1. 5 | 1.12 | 1.20 | 1.29 | 1.36 | 1.45 | 1.53 | 2. 5 | 2.16 | 2.28 | 2.42 | 2.59 | 3.17 |
| | 25 | 0 36 | 0.37 | 0.40 | 0.45 | 0.48 | 0.53 | 1. 2 | 1. 5 | 1.11 | 1.18 | 1.25 | 1.34 | 1.42 | 1.50 | 1.58 | 2.10 | 2.21 | 2.33 | 2.48 | 3. 4 | 3.22 |
| | 30 | 0.59 | 0.54 | 0.56 | 0.59 | 1. 2 | 1. 4 | 1.11 | 1.14 | 1.19 | 1.27 | 1.33 | 1.41 | 1.48 | 1.58 | 2. 6 | 2.18 | 2.28 | 2.41 | 2 56 | 3.12 | 3.31 |
| | 35 | 1.25 | 1.16 | 1.14 | 1.14 | 1.14 | 1.17 | 1.23 | 1.27 | 1.31 | 1.36 | 1.43 | 1.51 | 1.57 | 2. 6 | 2.15 | 2 26 | 2 36 | 2.50 | 3. 5 | 3.22 | 3.41 |
| | 40 | 1.52 | 1 40 | 1.33 | 1.30 | 1.30 | 1.30 | 1.35 | 1.37 | 1.42 | 1.46 | 1.53 | 2. 0 | 2. 6 | 2.15 | 2.24 | 2.36 | 2.47 | 3. 0 | 3.15 | 3.33 | 3.52 |
| | 45 | . | 2. 2 | 1.51 | 1.48 | 1.45 | 1.44 | 1.46 | 1.49 | 1.52 | 1.58 | 2. 2 | 2.10 | 2.16 | 2.25 | 2 34 | 2.45 | 2.58 | 3. 9 | 3.26 | 3.42 | 4. 3 |
| | 50 | . | . | 2.10 | 2. 1 | 1.58 | 1.56 | 1.59 | 2. 0 | 2. 0 | 2. 7 | 2.11 | 2.19 | 2.25 | 2.34 | 2.42 | 2.53 | 3. 5 | 3.18 | 3.34 | 3.53 | |
| | 55 | . | . | . | 2.17 | 2.11 | 2. 7 | 2. 9 | 2.10 | 2.11 | 2.16 | 2.20 | 2.28 | 2.33 | 2.43 | 2.51 | 3. 1 | 3.14 | 3.27 | 3.43 | | |
| | 60 | . | . | . | . | 2.23 | 2.18 | 2.19 | 2.19 | 2.20 | 2.24 | 2.29 | 2.35 | 2.40 | 2.50 | 2 58 | 3.10 | 3.21 | 3.35 | | | |
| | 65 | . | . | . | . | . | 2.28 | 2.28 | 2.26 | 2.27 | 2.31 | 2.36 | 2 43 | 2.48 | 2.57 | 3. 5 | 3.16 | 3.28 | | | | |
| | 70 | . | . | . | . | . | . | 2.35 | 2.33 | 2.34 | 2.38 | 2.41 | 2.48 | 2.54 | 3. 2 | 3.10 | 3.22 | | | | | |
| | 75 | . | . | . | . | . | . | . | 2.38 | 2.39 | 2.42 | 2.46 | 2.52 | 2.57 | 3. 5 | 3.15 | | | | | | |
| | 80 | . | . | . | . | . | . | . | . | 2.43 | 2.45 | 2.50 | 2.56 | 3· 0 | 3. 8 | | | | | | | |
| 19 | 19 | 0.19 | 0.24 | 0.30 | 0.36 | 0.40 | 0.47 | 0.54 | 0.59 | 1. 5 | 1.12 | 1.19 | 1.27 | 1.35 | 1.43 | 1.53 | 2. 3 | 2.15 | 2 27 | 2.41 | 2.58 | 3.15 |
| | 20 | 0.19 | 0.24 | 0.30 | 0.36 | 0.40 | 0.47 | 0.54 | 0.59 | 1. 5 | 1.12 | 1.20 | 1.29 | 1.36 | 1.44 | 1.53 | 2. 4 | 2.15 | 2.28 | 2.42 | 2.58 | 3.16 |
| | 25 | 0.27 | 0.34 | 0.37 | 0.42 | 0.46 | 0.52 | 1. 0 | 1. 4 | 1.10 | 1.16 | 1.24 | 1.33 | 1.40 | 1.48 | 1.57 | 2. 9 | 2.19 | 2.32 | 2.46 | 3. 3 | 3 20 |
| | 30 | 0.48 | 0.48 | 0.50 | 0.54 | 0.58 | 1. 0 | 1. 8 | 1.11 | 1.17 | 1.23 | 1.30 | 1.38 | 1.46 | 1.55 | 2. 4 | 2.15 | 2.26 | 2.38 | 2.53 | 3.10 | 3.28 |
| | 35 | 1.13 | 1. 8 | 1. 6 | 1. 9 | 1. 9 | 1.12 | 1.19 | 1.23 | 1.27 | 1.33 | 1.39 | 1.48 | 1.53 | 2. 3 | 2.12 | 2.23 | 2.34 | 2.47 | 3. 2 | 3.18 | 3.37 |
| | 40 | 1.39 | 1.30 | 1.24 | 1.23 | 1.22 | 1 25 | 1.36 | 1.32 | 1.37 | 1.41 | 1.49 | 1.56 | 2. 2 | 2.11 | 2.21 | 2.31 | 2.42 | 2.56 | 3.10 | 3.29 | 3.47 |
| | 45 | . | 1.49 | 1.42 | 1.39 | 1.37 | 1.38 | 1.40 | 1.43 | 1.47 | 1.51 | 1 58 | 2. 5 | 2.12 | 2.19 | 2.30 | 2.40 | 2.51 | 3. 6 | 3.20 | 3 37 | 3.57 |
| | 50 | . | . | 1.58 | 1.52 | 1.50 | 1.49 | 1.51 | 1.53 | 1.56 | 2. 0 | 2. 5 | 2.13 | 2.20 | 2.27 | 2.38 | 2.48 | 2.59 | 3.13 | 3.28 | 3.42 | |
| | 55 | . | . | . | 2. 6 | 2. 0 | 1.59 | 2. 2 | 2. 3 | 2. 5 | 2.10 | 2.15 | 2.22 | 2.28 | 2.35 | 2.46 | 2.56 | 3. 7 | 3.20 | 3.36 | | |
| | 60 | . | . | . | . | 2.12 | 2. 9 | 2.10 | 2.10 | 2.13 | 2.17 | 2.22 | 2.29 | 2.35 | 2.42 | 2.52 | 3. 2 | 3.14 | 3.28 | | | |
| | 65 | . | . | . | . | . | 2.18 | 2.19 | 2.18 | 2.20 | 2.23 | 2.29 | 2.36 | 2.41 | 2.48 | 2.59 | 3. 8 | 3.20 | | | | |
| | 70 | . | . | . | . | . | . | 2.25 | 2.25 | 2.26 | 2.29 | 2.34 | 2.40 | 2.47 | 2.53 | 3. 2 | 3.13 | | | | | |
| | 75 | . | . | . | . | . | . | . | 2.29 | 2.30 | 2.33 | 2.38 | 2.43 | 2.50 | 2.57 | 3. 6 | | | | | | |
| | 80 | . | . | . | . | . | . | . | . | 2.34 | 2.36 | 2.41 | 2.46 | 2.53 | 3. 0 | | | | | | | |
| 20 | 20 | 0.19 | 0.24 | 0.30 | 0.36 | 0.40 | 0.47 | 0.54 | 0.59 | 1. 5 | 1.12 | 1.19 | 1.27 | 1.35 | 1.43 | 1.53 | 2. 3 | 2.15 | 2.27 | 2 41 | 2.58 | 3.15 |
| | 25 | 0.27 | 0.31 | 0.35 | 0.40 | 0.44 | 0.51 | 0.59 | 1. 2 | 1. 8 | 1.15 | 1.23 | 1.32 | 1.39 | 1 47 | 1.57 | 2. 8 | 2.18 | 2.31 | 2.45 | 3. 2 | 3.20 |
| | 30 | 0.44 | 0.43 | 0.47 | 0.50 | 0.53 | 0.58 | 1. 6 | 1. 8 | 1.14 | 1.21 | 1.28 | 1.37 | 1.44 | 1.52 | 2. 2 | 2.13 | 2.24 | 2.36 | 2.51 | 3. 7 | 3 26 |
| | 35 | 1. 6 | 1. 1 | 1. 2 | 1. 2 | 1. 4 | 1. 8 | 1.15 | 1.19 | 1 23 | 1.29 | 1.36 | 1.44 | 1.50 | 1 59 | 2. 9 | 2.20 | 2.31 | 2.44 | 2.59 | 3.15 | 3.34 |
| | 40 | 1.28 | 1.20 | 1.17 | 1.17 | 1.17 | 1.20 | 1 24 | 1.28 | 1.32 | 1.37 | 1.44 | 1.52 | 1.59 | 2. 7 | 2.17 | 2.27 | 2.39 | 2.52 | 3. 7 | 3 24 | 3.44 |
| | 45 | . | 1.39 | 1.33 | 1.31 | 1.30 | 1.31 | 1.34 | 1.37 | 1.42 | 1.45 | 1.53 | 2. 0 | 2. 7 | 2.15 | 2 25 | 2.36 | 2.47 | 3. 0 | 3.15 | 3.33 | |
| | 50 | . | . | 1.47 | 1.44 | 1.41 | 1.41 | 1.45 | 1.47 | 1.50 | 1.54 | 2. 0 | 2. 8 | 2.15 | 2.23 | 2.32 | 2.42 | 2.55 | 3. 7 | 3.23 | | |
| | 55 | . | . | . | 1.56 | 1.52 | 1.51 | 1.55 | 1.56 | 1.58 | 2. 3 | 2. 9 | 2.16 | 2.22 | 2.31 | 2 40 | 2.50 | 3. 2 | 3.15 | | | |
| | 60 | . | . | . | . | 2. 2 | 2. 1 | 2. 1 | 2. 2 | 2. 5 | 2. 9 | 2.16 | 2.22 | 2.28 | 2.37 | 2.47 | 2.56 | 3. 9 | | | | |
| | 65 | . | . | . | . | . | 2. 9 | 2. 9 | 2. 9 | 2.12 | 2.16 | 2.22 | 2.29 | 2.34 | 2.42 | 2.52 | 3. 3 | | | | | |
| | 70 | . | . | . | . | . | . | 2.15 | 2.16 | 2.18 | 2.20 | 2 27 | 2.33 | 2.38 | 2.46 | 2.57 | | | | | | |
| | 75 | . | . | . | . | . | . | . | 2.21 | 2.22 | 2.24 | 2.31 | 2.37 | 2.42 | 2.50 | | | | | | | |
| | 80 | . | . | . | . | . | . | . | . | 2.26 | 2.28 | 2.34 | 2.40 | 2.46 | | | | | | | | |
| 21 | 21 | 0.19 | 0.24 | 0.30 | 0.36 | 0.40 | 0.47 | 0.54 | 0.59 | 1. 5 | 1.12 | 1.19 | 1.27 | 1.35 | 1.43 | 1.53 | 2. 3 | 2 15 | 2.27 | 2.41 | 2 58 | 3.15 |
| | 25 | 0.22 | 0.29 | 0.33 | 0.39 | 0.43 | 0.49 | 0.58 | 1. 1 | 1. 7 | 1.14 | 1.22 | 1.31 | 1.38 | 1.46 | 1.56 | 2. 6 | 2.17 | 2.30 | 2 44 | 3. 0 | 3.19 |
| | 30 | 0.36 | 0.40 | 0.42 | 0.49 | 0.51 | 0.56 | 1. 4 | 1. 7 | 1.12 | 1.19 | 1.26 | 1.35 | 1.43 | 1.50 | 2. 0 | 2.11 | 2 23 | 2 36 | 2.49 | 3. 5 | 3.24 |
| | 35 | 0.56 | 0.55 | 0.55 | 0.59 | 1. 1 | 1. 4 | 1.12 | 1.16 | 1.20 | 1.26 | 1.34 | 1.41 | 1.48 | 1.57 | 2. 6 | 2.18 | 2.28 | 2.42 | 2.56 | 3.12 | 3.31 |
| | 40 | 1.17 | 1.13 | 1 10 | 1.10 | 1.12 | 1.15 | 1.20 | 1.24 | 1.29 | 1.34 | 1.40 | 1.49 | 1.55 | 2. 4 | 2.13 | 2.24 | 2.35 | 2.49 | 3 3 | 3.20 | 3.39 |
| | 45 | 1.39 | 1.31 | 1.24 | 1.24 | 1.24 | 1.26 | 1.30 | 1.32 | 1.37 | 1.41 | 1.49 | 1.56 | 2. 3 | 2.12 | 2.21 | 2.32 | 2.42 | 2.56 | 3.10 | 3.28 | |
| | 50 | . | 1.45 | 1.39 | 1.35 | 1.35 | 1.36 | 1.40 | 1.41 | 1.45 | 1.49 | 1.56 | 2. 4 | 2.11 | 2.19 | 2.28 | 2.39 | 2.48 | 3. 3 | 3.18 | | |
| | 55 | . | . | 1.52 | 1.43 | 1.45 | 1.45 | 1.49 | 1.50 | 1.53 | 1.59 | 2. 3 | 2.10 | 2.17 | 2.26 | 2.35 | 2 45 | 2.56 | 3. 9 | | | |
| | 60 | . | . | . | 1.58 | 1.54 | 1.53 | 1.55 | 1.56 | 2. 0 | 2. 4 | 2.10 | 2.16 | 2.23 | 2.31 | 2.41 | 2.51 | 3. 3 | | | | |
| | 65 | . | . | . | . | 2. 2 | 2. 1 | 2. 3 | 2. 2 | 2. 6 | 2.10 | 2.15 | 2.21 | 2.30 | 2.37 | 2.46 | 2.56 | | | | | |
| | 70 | . | . | . | . | . | 2. 7 | 2. 9 | 2. 9 | 2.11 | 2.15 | 2.20 | 2.26 | 2.34 | 2.42 | 2.50 | | | | | | |
| | 75 | . | . | . | . | . | . | 2.13 | 2.13 | 2.15 | 2.18 | 2.23 | 2 29 | 2.36 | 2.45 | | | | | | | |
| | 80 | . | . | . | . | . | . | . | 2.16 | 2.18 | 2.21 | 2.26 | 2.32 | 2.39 | | | | | | | | |

# TABLE I.

The Effect of Refraction on the Distance between the Moon and the Sun, Fixed Star, or Planet.

| Less Altitude | Greater Altitude | APPARENT DISTANCE. | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 55° | 60° | 65° | 70° | 75° | 80° | 85° | 90° | 95° | 100° | 105° | 110° | 115° | 120° |
| ° | ° | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ |
| 22 | 22 | 0.19 | 0.25 | 0.30 | 0.36 | 0.40 | 0.47 | 0.54 | 0.58 | 1. 5 | 1.12 | 1.20 | 1.28 | 1.36 | 1.44 | 1.53 | 2. 3 | 2 15 | 2.27 | 2.41 | 2.58 | 3.16 |
| | 25 | 0.20 | 0.27 | 0.32 | 0.38 | 0.43 | 0.48 | 0.57 | 1. 0 | 1. 6 | 1.13 | 1.21 | 1 30 | 1.37 | 1.46 | 1.55 | 2. 6 | 2.16 | 2.29 | 2.43 | 3. 0 | 3.18 |
| | 30 | 0.30 | 0.36 | 0.39 | 0.46 | 0.49 | 0.54 | 1. 1 | 1. 5 | 1.10 | 1.17 | 1.25 | 1.33 | 1.41 | 1.50 | 1.59 | 2.10 | 2.21 | 2.33 | 2.48 | 3. 4 | 3.22 |
| | 35 | 0.50 | 0.50 | 0.51 | 0.54 | 0.58 | 1. 1 | 1. 9 | 1.13 | 1.17 | 1.23 | 1.31 | 1.39 | 1.46 | 1.55 | 2. 4 | 2.16 | 2.26 | 2.39 | 2.54 | 3 10 | 3.28 |
| | 40 | 1. 8 | 1. 6 | 1. 4 | 1. 6 | 1. 8 | 1.11 | 1.17 | 1.21 | 1.25 | 1.30 | 1.37 | 1.46 | 1.52 | 2. 2 | 2 10 | 2.22 | 2.32 | 2.46 | 3. 1 | 3.17 | 3.36 |
| | 45 | 1.30 | 1.21 | 1.17 | 1.18 | 1.18 | 1.21 | 1.25 | 1 28 | 1.34 | 1.38 | 1.45 | 1.53 | 2. 0 | 2. 9 | 2.18 | 2.28 | 2.40 | 2.53 | 3. 7 | 3.24 | |
| | 50 | . | 1.37 | 1.30 | 1.28 | 1.30 | 1.30 | 1.34 | 1.37 | 1.40 | 1.45 | 1.52 | 2. 0 | 2. 7 | 2.16 | 2.24 | 2.35 | 2.46 | 2.59 | 3.14 | | |
| | 55 | . | . | 1.40 | 1.40 | 1.39 | 1.38 | 1.42 | 1.44 | 1.48 | 1.53 | 1.59 | 2. 6 | 2.12 | 2.22 | 2.30 | 2.41 | 2.52 | 3. 5 | | | |
| | 60 | . | . | | 1.51 | 1.47 | 1.46 | 1.50 | 1.50 | 1.55 | 1.59 | 2. 4 | 2.12 | 2.18 | 2.27 | 2.36 | 2.47 | 2.58 | | | | |
| | 65 | . | . | | . | 1.53 | 1.53 | 1.55 | 1.57 | 2. 0 | 2. 5 | 2.10 | 2.18 | 2.23 | 2.32 | 2.41 | 2.51 | | | | | |
| | 70 | . | . | . | . | . | 1.59 | 2. 1 | 2. 2 | 2. 5 | 2. 9 | 2.14 | 2.21 | 2.29 | 2.36 | 2.45 | | | | | | |
| | 75 | . | . | | . | . | . | 2. 5 | 2. 7 | 2. 9 | 2.12 | 2.18 | 2.24 | 2.31 | 2.39 | | | | | | | |
| | 80 | . | . | . | . | . | . | . | 2. 9 | 2.12 | 2.15 | 2.21 | 2.28 | | | | | | | | | |
| 23 | 23 | 0.19 | 0.25 | 0.30 | 0.36 | 0 40 | 0.47 | 0.54 | 0.59 | 1. 5 | 1.12 | 1.20 | 1.28 | 1.36 | 1.44 | 1.53 | 2. 3 | 2.15 | 2.27 | 2.41 | 2.58 | 3.16 |
| | 25 | 0.20 | 0.26 | 0.31 | 0.37 | 0.42 | 0.48 | 0.56 | 1. 0 | 1. 5 | 1.13 | 1.21 | 1.29 | 1.37 | 1.45 | 1.54 | 2. 5 | 2.16 | 2.28 | 2.43 | 3. 0 | 3.16 |
| | 30 | 0.29 | 0.33 | 0.36 | 0.43 | 0.48 | 0.53 | 1. 0 | 1. 4 | 1. 9 | 1.16 | 1.24 | 1 32 | 1.40 | 1.49 | 1.58 | 2. 9 | 2.20 | 2 32 | 2.46 | 3. 3 | 3 20 |
| | 35 | 0.43 | 0.45 | 0.46 | 0.50 | 0.54 | 0 59 | 1. 6 | 1.10 | 1.15 | 1.21 | 1.29 | 1.36 | 1.44 | 1 53 | 2. 2 | 2.13 | 2.24 | 2.37 | 2 51 | 3. 8 | 3.25 |
| | 40 | 1. 0 | 0.59 | 0.59 | 1. 1 | 1. 4 | 1. 7 | 1.13 | 1.18 | 1.21 | 1.27 | 1.35 | 1 42 | 1.50 | 1.59 | 2. 8 | 2.19 | 2.30 | 2.43 | 2 58 | 3.14 | 3.33 |
| | 45 | 1.22 | 1.15 | 1.10 | 1.12 | 1.13 | 1.16 | 1.21 | 1.25 | 1.30 | 1.34 | 1.42 | 1.50 | 1.57 | 2. 6 | 2.15 | 2.25 | 2.37 | 2.49 | 3. 4 | 3.21 | |
| | 50 | . | 1.29 | 1.23 | 1.21 | 1.22 | 1.24 | 1.29 | 1.32 | 1.36 | 1.40 | 1.48 | 1.55 | 2. 3 | 2.12 | 2.20 | 2.31 | 2.43 | 2.55 | 3.10 | | |
| | 55 | . | . | 1.36 | 1.31 | 1.31 | 1.32 | 1.37 | 1.39 | 1.43 | 1.47 | 1.55 | 2. 1 | 2. 9 | 2.18 | 2.26 | 2.37 | 2.49 | 3. 1 | | | |
| | 60 | . | . | . | 1.43 | 1.40 | 1.40 | 1.44 | 1.44 | 1.49 | 1.53 | 2. 0 | 2. 8 | 2.14 | 2.22 | 2.31 | 2.42 | 2.53 | | | | |
| | 65 | . | . | . | . | 1.48 | 1.46 | 1.50 | 1.50 | 1.54 | 2. 0 | 2. 4 | 2.12 | 2.19 | 2.27 | 2 36 | 2.46 | | | | | |
| | 70 | . | . | . | . | . | 1.53 | 1.55 | 1.56 | 2. 0 | 2. 3 | 2. 9 | 2.16 | 2.23 | 2.31 | 2.40 | | | | | | |
| | 75 | . | . | . | . | . | . | 2.59 | 2. 0 | 2. 3 | 2. 6 | 2.12 | 2.19 | 2.26 | 2.35 | | | | | | | |
| | 80 | . | . | . | . | . | . | . | 2. 2 | 2. 6 | 2. 9 | 2.15 | 2.21 | 2.29 | | | | | | | | |
| 24 | 24 | 0.19 | 0.25 | 0.30 | 0.36 | 0.40 | 0.47 | 0.54 | 0 59 | 1. 5 | 1.12 | 1.20 | 1.28 | 1.36 | 1.44 | 1.53 | 2. 3 | 2.15 | 2.27 | 2.41 | 2.58 | 3.16 |
| | 25 | 0.20 | 0.25 | 0.30 | 0.36 | 0.40 | 0.47 | 0.54 | 0.59 | 1. 5 | 1.12 | 1.20 | 1.28 | 1.36 | 1.44 | 1.53 | 2. 4 | 2.15 | 2 27 | 2.42 | 2.59 | 3.16 |
| | 30 | 0.28 | 0.30 | 0.34 | 0.41 | 0.46 | 0.51 | 0.59 | 1. 2 | 1. 8 | 1.15 | 1.23 | 1.31 | 1.39 | 1.47 | 1.57 | 2. 8 | 2.19 | 2 31 | 2.46 | 3. 2 | 3.20 |
| | 35 | 0.41 | 0.40 | 0.42 | 0.47 | 0.51 | 0.56 | 1. 3 | 1. 8 | 1.13 | 1.19 | 1.27 | 1.35 | 1.43 | 1.51 | 2. 1 | 2.11 | 2.22 | 2.36 | 2.50 | 3. 6 | 3.25 |
| | 40 | 0.57 | 0.54 | 0.53 | 0.57 | 1. 0 | 1. 3 | 1.10 | 1.15 | 1.19 | 1.24 | 1.33 | 1.40 | 1.47 | 1.57 | 2. 5 | 2.16 | 2.28 | 2 41 | 2.56 | 3.12 | 3.30 |
| | 45 | 1.13 | 1. 8 | 1. 5 | 1. 6 | 1. 9 | 1.12 | 1.17 | 1.21 | 1.26 | 1.31 | 1.39 | 1.46 | 1.53 | 2. 3 | 2.11 | 2.22 | 2.34 | 2.46 | 3. 1 | 3.18 | |
| | 50 | . | 1.19 | 1.17 | 1.16 | 1.18 | 1.20 | 1.25 | 1.28 | 1.33 | 1.37 | 1.45 | 1.52 | 2. 0 | 2. 8 | 2.16 | 2.28 | 2.39 | 2.52 | 3. 7 | | |
| | 55 | . | . | 1.28 | 1.26 | 1.26 | 1.28 | 1.31 | 1.34 | 1.39 | 1.43 | 1.50 | 1.58 | 2. 5 | 2.13 | 2.22 | 2.33 | 2.44 | 2.57 | | | |
| | 60 | . | . | . | 1.35 | 1.33 | 1.34 | 1.39 | 1.39 | 1.44 | 1.48 | 1.56 | 2. 2 | 2.10 | 2.18 | 2.27 | 2.38 | 2.50 | | | | |
| | 65 | . | . | . | . | 1.39 | 1.41 | 1.44 | 1.45 | 1.50 | 1.54 | 2. 0 | 2. 8 | 2.14 | 2.23 | 2.31 | 2.44 | | | | | |
| | 70 | . | . | . | . | . | 1.45 | 1.50 | 1.50 | 1.54 | 1.59 | 2. 4 | 2.11 | 2.19 | 2.27 | 2.35 | | | | | | |
| | 75 | . | . | . | . | . | . | 1.52 | 1.53 | 1.58 | 2. 2 | 2. 7 | 2.14 | 2.21 | 2.29 | | | | | | | |
| | 80 | . | . | . | . | . | . | . | 1.56 | 2. 0 | 2. 4 | 2.10 | 2.17 | 2.23 | | | | | | | | |
| 25 | 25 | 0.19 | 0.25 | 0.30 | 0.36 | 0.40 | 0.47 | 0.54 | 0.59 | 1. 5 | 1.12 | 1.20 | 1.28 | 1.36 | 1.44 | 1.53 | 2. 3 | 2.15 | 2.27 | 2.41 | 2.58 | 3.16 |
| | 30 | 0.23 | 0.28 | 0.33 | 0.39 | 0.44 | 0.50 | 0.58 | 1. 2 | 1. 7 | 1.14 | 1.22 | 1.30 | 1.38 | 1.47 | 1.56 | 2. 7 | 2.18 | 2.30 | 2.45 | 3. 1 | 3.19 |
| | 35 | 0.33 | 0.36 | 0.39 | 0.44 | 0.49 | 0.54 | 1. 1 | 1. 6 | 1.11 | 1.17 | 1.26 | 1.33 | 1.41 | 1.50 | 1.59 | 2.10 | 2.21 | 2.34 | 2.48 | 3. 4 | 3.23 |
| | 40 | 0.48 | 0.48 | 0.49 | 0.53 | 0.57 | 1. 0 | 1. 7 | 1.11 | 1.17 | 1.22 | 1.30 | 1.38 | 1.45 | 1.55 | 2. 3 | 2.15 | 2.26 | 2.39 | 2.53 | 3.10 | |
| | 45 | 1. 5 | 1. 2 | 1. 0 | 1. 2 | 1. 5 | 1. 8 | 1.14 | 1.18 | 1.23 | 1.28 | 1.36 | 1.43 | 1.50 | 2. 0 | 2.10 | 2.20 | 2.31 | 2.44 | 2.58 | | |
| | 50 | . | 1.14 | 1.10 | 1.11 | 1.13 | 1.16 | 1.21 | 1.24 | 1.30 | 1.34 | 1.41 | 1.49 | 1.56 | 2. 5 | 2.13 | 2.25 | 2 36 | 2.50 | | | |
| | 55 | . | . | 1.22 | 1.20 | 1.20 | 1.23 | 1.27 | 1.30 | 1.35 | 1.40 | 1.47 | 1.54 | 2. 1 | 2.10 | 2.19 | 2.30 | 2.41 | | | | |
| | 60 | . | . | . | 1.29 | 1.27 | 1.30 | 1.33 | 1.35 | 1.40 | 1.45 | 1.52 | 1.59 | 2. 5 | 2.14 | 2.24 | 2.35 | | | | | |
| | 65 | . | . | . | . | 1.35 | 1.36 | 1.39 | 1.40 | 1.45 | 1.50 | 1.56 | 2. 3 | 2.10 | 2.19 | 2.29 | | | | | | |
| | 70 | . | . | . | . | . | 1.41 | 1.44 | 1.45 | 1.49 | 1.54 | 2. 0 | 2. 7 | 2.14 | 2.23 | | | | | | | |
| | 75 | . | . | . | . | . | . | 1.47 | 1.49 | 1.53 | 1.57 | 2. 3 | 2.10 | 2.17 | | | | | | | | |
| | 80 | . | . | . | . | . | . | . | 1.52 | 1.56 | 2. 0 | 2. 6 | 2.12 | | | | | | | | | |
| 26 | 26 | 0.19 | 0.25 | 0.30 | 0.36 | 0.40 | 0.47 | 0.54 | 0.59 | 1. 5 | 1.12 | 1.20 | 1.28 | 1.36 | 1.44 | 1.53 | 2. 3 | 2.15 | 2.27 | 2.41 | 2.58 | 3.16 |
| | 30 | 0.22 | 0.27 | 0.32 | 0.38 | 0.43 | 0.49 | 0.57 | 1. 1 | 1. 6 | 1.13 | 1.22 | 1.29 | 1.38 | 1.46 | 1.55 | 2. 6 | 2.17 | 2.30 | 2.44 | 3. 0 | 3.18 |
| | 35 | 0.30 | 0.33 | 0.37 | 0.43 | 0.47 | 0.52 | 1. 0 | 1. 4 | 1. 9 | 1.16 | 1.25 | 1.32 | 1.40 | 1.49 | 1.58 | 2. 9 | 2.20 | 2.33 | 2.47 | 3. 3 | 3.21 |
| | 40 | 0.42 | 0.43 | 0.46 | 0.49 | 0.53 | 0.58 | 1. 5 | 1. 9 | 1.14 | 1.20 | 1.28 | 1.36 | 1.44 | 1.53 | 2. 2 | 2.13 | 2.24 | 2.37 | 2.51 | 3. 7 | |
| | 45 | 0.59 | 0.56 | 0.55 | 0.58 | 1. 1 | 1. 5 | 1.11 | 1.15 | 1.21 | 1.26 | 1.34 | 1.41 | 1.48 | 1.58 | 2. 6 | 2.17 | 2.28 | 2.41 | 2.56 | | |
| | 50 | 1.13 | 1. 8 | 1. 7 | 1. 6 | 1. 9 | 1.11 | 1.18 | 1.21 | 1.26 | 1.32 | 1.39 | 1.46 | 1.53 | 2. 2 | 2.11 | 2.22 | 2.33 | 2.46 | | | |
| | 55 | . | 1.19 | 1.16 | 1.14 | 1.17 | 1.19 | 1.25 | 1.27 | 1.32 | 1.37 | 1.43 | 1.52 | 1.58 | 2. 7 | 2.16 | 2.27 | 2.38 | | | | |
| | 60 | . | . | 1.26 | 1.22 | 1.24 | 1.24 | 1.31 | 1.33 | 1.36 | 1.41 | 1.48 | 1.56 | 2. 2 | 2.10 | 2.21 | 2.32 | | | | | |
| | 65 | . | . | . | 1.31 | 1.30 | 1.30 | 1.36 | 1.36 | 1.42 | 1.46 | 1.52 | 2. 0 | 2. 6 | 2.15 | 2.25 | | | | | | |
| | 70 | . | . | . | | 1.35 | 1.35 | 1.38 | 1.40 | 1.46 | 1.49 | 1.55 | 2. 3 | 2.10 | 2.19 | | | | | | | |
| | 75 | . | . | . | | . | 1.40 | 1.41 | 1.44 | 1.49 | 1.52 | 1.58 | 2. 6 | 2.13 | | | | | | | | |
| | 80 | . | . | . | . | . | . | 1.44 | 1.47 | 1.51 | 1.54 | 2. 1 | 2. 8 | | | | | | | | | |

# TABLE I.

## The Effect of Refraction on the Distance between the Moon and the Sun, Fixed Star, or Planet.

| Less Altitude. | Greater Altitude | APPARENT DISTANCE. | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 55° | 60° | 65° | 70° | 75° | 80° | 85° | 90° | 95° | 100° | 105° | 110° | 115° | 120° |
| ° | ° | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ |
| 27 | 27 | 0 20 | 0.25 | 0.30 | 0.36 | 0.40 | 0.47 | 0.54 | 0.59 | 1. 6 | 1.12 | 1.20 | 1.28 | 1.36 | 1.44 | 1.53 | 2. 3 | 2.15 | 2.27 | 2.42 | 2.58 | 3.16 |
| | 30 | 0.22 | 0 27 | 0.32 | 0.37 | 0.42 | 0.48 | 0.56 | 1. 0 | 1. 7 | 1.12 | 1.20 | 1.29 | 1.37 | 1.46 | 1.54 | 2. 6 | 2 17 | 2.29 | 2.43 | 3. 0 | 3.18 |
| | 35 | 0.30 | 0.33 | 0.35 | 0.41 | 0 46 | 0.51 | 0.59 | 1. 3 | 1.10 | 1.15 | 1.24 | 1.31 | 1.40 | 1.48 | 1.57 | 2. 8 | 2.19 | 2.32 | 2 47 | 3. 3 | 3.20 |
| | 40 | 0.41 | 0.42 | 0.42 | 0.47 | 0.51 | 0.56 | 1. 3 | 1. 8 | 1.14 | 1.19 | 1 27 | 1.34 | 1.42 | 1.52 | 2. 0 | 2.12 | 2.22 | 2.36 | 2.50 | 3. 6 | |
| | 45 | 0.54 | 0.53 | 0.52 | 0.55 | 0.58 | 1. 2 | 1. 9 | 1.12 | 1.19 | 1.24 | 1 32 | 1.39 | 1.46 | 1.56 | 2. 5 | 2.16 | 2.26 | 2.40 | 2.54 | | |
| | 50 | 1. 6 | 1. 2 | 1. 2 | 1. 2 | 1. 6 | 1. 8 | 1.14 | 1.19 | 1.24 | 1.29 | 1.36 | 1.43 | 1.50 | 2. 0 | 2. 9 | 2.20 | 2.31 | 2.44 | | | |
| | 55 | . | 1.13 | 1.11 | 1.10 | 1.11 | 1.15 | 1.20 | 1 24 | 1.29 | 1.34 | 1.41 | 1.48 | 1.55 | 2. 5 | 2.13 | 2.25 | 2.36 | | | | |
| | 60 | . | . | 1.20 | 1 19 | 1.18 | 1.20 | 1.26 | 1.28 | 1.34 | 1.38 | 1.45 | 1.53 | 1.59 | 2. 8 | 2.17 | 2.29 | | | | | |
| | 65 | . | . | . | 1.26 | 1.25 | 1.26 | 1.30 | 1.32 | 1.38 | 1.42 | 1.49 | 1.57 | 2. 2 | 2.12 | 2.22 | | | | | | |
| | 70 | . | . | . | . | 1.30 | 1.30 | 1.34 | 1.36 | 1.42 | 1.46 | 1 52 | 2. 0 | 2. 5 | 2.15 | | | | | | | |
| | 75 | . | . | . | . | . | 1.35 | 1.37 | 1.40 | 1.45 | 1.49 | 1.56 | 2. 2 | 2. 9 | | | | | | | | |
| | 80 | . | . | . | . | . | . | 1.39 | 1.43 | 1.47 | 1.51 | 1.58 | 2. 4 | | | | | | | | | |
| 28 | 28 | 0.20 | 0.25 | 0.30 | 0.36 | 0.40 | 0.47 | 0.54 | 0 59 | 1. 6 | 1 12 | 1.20 | 1.28 | 1.36 | 1.44 | 1.52 | 2. 3 | 2.15 | 2.27 | 2.42 | 2.58 | 3.16 |
| | 30 | 0.21 | 0.26 | 0.31 | 0.37 | 0.42 | 0.48 | 0 56 | 1. 0 | 1. 6 | 1.12 | 1.20 | 1.28 | 1.37 | 1.45 | 1.54 | 2. 5 | 2.16 | 2.29 | 2.43 | 2.58 | 3.18 |
| | 35 | 0.28 | 0.31 | 0.34 | 0 40 | 0.45 | 0.50 | 0.58 | 1. 3 | 1. 7 | 1.15 | 1.23 | 1 30 | 1.39 | 1.47 | 1.57 | 2. 7 | 2.18 | 2.31 | 2.46 | 3. 1 | 3.19 |
| | 40 | 0.38 | 0.39 | 0.40 | 0.45 | 0.49 | 0.55 | 1. 2 | 1. 6 | 1.12 | 1.18 | 1.26 | 1.33 | 1.42 | 1.50 | 1.59 | 2.10 | 2.21 | 2.34 | 2.49 | 3. 5 | |
| | 45 | 0.49 | 0.49 | 0.48 | 0.52 | 0.57 | 1. 0 | 1. 7 | 1.10 | 1.16 | 1.22 | 1.30 | 1 37 | 1.45 | 1.55 | 2. 3 | 2 14 | 2.25 | 2.38 | 2.52 | | |
| | 50 | 1. 1 | 0.58 | 0.56 | 1. 1 | 1. 3 | 1. 6 | 1.12 | 1.16 | 1 21 | 1.27 | 1.34 | 1.41 | 1.49 | 1.59 | 2. 7 | 2.18 | 2.30 | 2.42 | | | |
| | 55 | . | 1. 9 | 1. 7 | 1. 9 | 1.10 | 1.12 | 1 18 | 1.21 | 1.26 | 1.32 | 1.38 | 1.46 | 1.54 | 2. 3 | 2.12 | 2.23 | 2.34 | | | | |
| | 60 | . | . | 1.15 | 1.15 | 1.16 | 1.18 | 1 22 | 1.25 | 1.30 | 1.36 | 1.42 | 1.50 | 1 58 | 2. 6 | 2.16 | 2.25 | | | | | |
| | 65 | . | . | . | 1.21 | 1.21 | 1.23 | 1.27 | 1 28 | 1.34 | 1.40 | 1.46 | 1.54 | 2. 1 | 2. 9 | 2.19 | | | | | | |
| | 70 | . | . | . | . | 1.26 | 1.28 | 1.31 | 1.32 | 1.37 | 1.43 | 1.49 | 1.57 | 2. 4 | 2.12 | | | | | | | |
| | 75 | . | . | . | . | . | 1.31 | 1.34 | 1.36 | 1.40 | 1.45 | 1.51 | 1.59 | 2. 6 | | | | | | | | |
| | 80 | . | . | . | . | . | . | 1.36 | 1.39 | 1.42 | 1.47 | 1.53 | 2. 1 | | | | | | | | | |
| 29 | 29 | 0.19 | 0.25 | 0.30 | 0.36 | 0.40 | 0.47 | 0.54 | 0.59 | 1. 6 | 1.12 | 1.20 | 1.28 | 1.36 | 1.44 | 1.54 | 2. 4 | 2.15 | 2.28 | 2.42 | 2.58 | 3.16 |
| | 30 | 0 20 | 0.25 | 0.30 | 0.37 | 0.40 | 0.47 | 0.55 | 1. 0 | 1. 6 | 1.12 | 1.20 | 1.28 | 1.36 | 1.44 | 1.54 | 2. 5 | 2.16 | 2.28 | 2.42 | 2.59 | 3.17 |
| | 35 | 0.26 | 0.30 | 0.33 | 0.39 | 0.43 | 0.49 | 0.57 | 1. 2 | 1. 8 | 1.14 | 1.23 | 1.30 | 1.3 | 1.46 | 1.56 | 2. 7 | 2.18 | 2.30 | 2.45 | 2.59 | 3.18 |
| | 40 | 0.35 | 0.37 | 0.38 | 0.44 | 0.48 | 0.53 | 1. 1 | 1. 5 | 1.12 | 1.17 | 1.25 | 1.32 | 1.41 | 1.50 | 1.58 | 2.10 | 2.20 | 2.34 | 2.47 | 3. 3 | |
| | 45 | 0.45 | 0.45 | 0.46 | 0.50 | 0 54 | 0 58 | 1. 5 | 1. 9 | 1.16 | 1 21 | 1.28 | 1.36 | 1.44 | 1.53 | 2. 2 | 2 13 | 2.23 | 2.37 | 2.51 | | |
| | 50 | 0.55 | 0.53 | 0.53 | 0.57 | 1. 0 | 1. 3 | 1 11 | 1.13 | 1.20 | 1.25 | 1.32 | 1.39 | 1.47 | 1.57 | 2. 6 | 2.16 | 2.27 | 2.40 | | | |
| | 55 | . | 1. 4 | 1. 2 | 1. 5 | 1. 6 | 1.10 | 1.16 | 1.18 | 1.25 | 1.30 | 1.37 | 1.44 | 1.52 | 2. 1 | 2.10 | 2.20 | 2.31 | | | | |
| | 60 | . | . | 1. 9 | 1.11 | 1.12 | 1.15 | 1.20 | 1.23 | 1.29 | 1.34 | 1.40 | 1.48 | 1.56 | 2. 4 | 2.13 | 2.24 | | | | | |
| | 65 | . | . | . | 1.17 | 1.17 | 1.20 | 1.24 | 1.26 | 1.33 | 1.38 | 1.44 | 1.52 | 1.59 | 2. 7 | 2.17 | | | | | | |
| | 70 | . | . | . | . | 1.22 | 1.23 | 1.28 | 1.30 | 1.36 | 1.41 | 1.46 | 1.55 | 2. 1 | 2.10 | | | | | | | |
| | 75 | . | . | . | . | . | 1.27 | 1.30 | 1.33 | 1.38 | 1.43 | 1.48 | 1.57 | 2. 4 | | | | | | | | |
| | 80 | . | . | . | . | . | . | 1.32 | 1.36 | 1.40 | 1.45 | 1 50 | 1.58 | | | | | | | | | |
| 30 | 30 | 0.19 | 0.25 | 0.30 | 0.36 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 6 | 1 12 | 1 20 | 1.28 | 1.36 | 1.44 | 1 54 | 2. 4 | 2.15 | 2.28 | 2.42 | 2.58 | 3.16 |
| | 35 | 0.23 | 0.28 | 0.33 | 0.37 | 0.43 | 0.48 | 0.55 | 1. 0 | 1. 8 | 1.14 | 1.21 | 1.29 | 1.37 | 1.45 | 1.55 | 2. 5 | 2.17 | 2.29 | 2.43 | 3. 0 | |
| | 40 | 0.30 | 0.34 | 0.38 | 0.42 | 0.47 | 0 52 | 0.58 | 1. 3 | 1.11 | 1.17 | 1.24 | 1.32 | 1.39 | 1 48 | 1.57 | 2 8 | 2.19 | 2.32 | 2.46 | | |
| | 45 | 0.40 | 0.41 | 0.44 | 0.47 | 0.52 | 0.57 | 1. 2 | 1. 7 | 1.14 | 1.20 | 1.27 | 1.35 | 1 42 | 1 51 | 2. 1 | 2.11 | 2.22 | 2.35 | | | |
| | 50 | 0.50 | 0.49 | 0.51 | 0.53 | 0.57 | 1. 1 | 1. 7 | 1.11 | 1.18 | 1.24 | 1.31 | 1 38 | 1.46 | 1.55 | 2. 4 | 2.15 | 2.26 | | | | |
| | 55 | . | 0.58 | 0.58 | 1. 0 | 1. 3 | 1. 7 | 1.12 | 1.16 | 1.22 | 1 28 | 1.35 | 1.42 | 1.50 | 1 58 | 2. 8 | 2.18 | | | | | |
| | 60 | | . | 1. 6 | 1. 6 | 1. 9 | 1.12 | 1.16 | 1.20 | 1.27 | 1.32 | 1.39 | 1.46 | 1.53 | 2. 2 | 2.11 | | | | | | |
| | 65 | . | . | . | 1.11 | 1.13 | 1.16 | 1.20 | 1.24 | 1.30 | 1.35 | 1.42 | 1.49 | 1.56 | 2. 5 | | | | | | | |
| | 70 | . | . | . | . | 1.17 | 1.20 | 1.24 | 1.27 | 1.33 | 1.38 | 1.45 | 1.52 | 1.59 | | | | | | | | |
| | 75 | . | . | . | . | . | 1.23 | 1.26 | 1.30 | 1.35 | 1.40 | 1.47 | 1.54 | | | | | | | | | |
| | 80 | . | . | . | . | . | . | 1.28 | 1.32 | 1.37 | 1.42 | 1.48 | | | | | | | | | | |
| 31 | 31 | 0.19 | 0.25 | 0.30 | 0.36 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 6 | 1.12 | 1.20 | 1.28 | 1.36 | 1.44 | 1.54 | 2. 4 | 2.15 | 2.28 | 2.42 | 2.58 | 3.16 |
| | 35 | 0.22 | 0.27 | 0.32 | 0.37 | 0.42 | 0.48 | 0.54 | 1. 0 | 1. 7 | 1.13 | 1.21 | 1.29 | 1.36 | 1.45 | 1.55 | 2. 5 | 2.16 | 2.29 | 2.43 | 3. 0 | |
| | 40 | 0.28 | 0.32 | 0.36 | 0.40 | 0.45 | 0.51 | 0.57 | 1. 2 | 1. 9 | 1.16 | 1.23 | 1.31 | 1.38 | 1 47 | 1 57 | 2. 7 | 2.18 | 2.32 | 2.45 | | |
| | 45 | 0.37 | 0.39 | 0.42 | 0.46 | 0.50 | 0.55 | 1. 1 | 1. 6 | 1.13 | 1.19 | 1.26 | 1.34 | 1.42 | 1.50 | 2. 0 | 2.10 | 2.22 | 2.35 | | | |
| | 50 | 0.46 | 0.46 | 0.48 | 0.51 | 0.55 | 1. 0 | 1. 5 | 1.10 | 1.17 | 1.22 | 1.30 | 1 37 | 1.45 | 1.53 | 2. 3 | 2.13 | 2.25 | | | | |
| | 55 | 0.55 | 0.54 | 0.55 | 0.57 | 1. 0 | 1. 5 | 1. 9 | 1.14 | 1.20 | 1.26 | 1.33 | 1.40 | 1.48 | 1.56 | 2. 6 | 2.16 | | | | | |
| | 60 | . | 1. 3 | 1. 2 | 1. 3 | 1. 6 | 1.10 | 1.14 | 1.18 | 1.25 | 1.30 | 1.37 | 1.44 | 1 52 | 2. 0 | 2.10 | | | | | | |
| | 65 | . | . | 1. 8 | 1. 8 | 1.10 | 1.14 | 1.18 | 1.22 | 1.28 | 1.33 | 1.40 | 1.47 | 1 54 | 2. 3 | | | | | | | |
| | 70 | . | . | . | 1.12 | 1.14 | 1.17 | 1.21 | 1.25 | 1.30 | 1.36 | 1.42 | 1.49 | 1 57 | | | | | | | | |
| | 75 | . | . | . | . | 1.17 | 1.20 | 1.23 | 1.27 | 1.33 | 1.38 | 1.44 | 1.51 | | | | | | | | | |
| | 80 | . | . | . | . | . | 1.23 | 1.25 | 1.29 | 1.35 | 1.39 | 1.46 | | | | | | | | | | |

# TABLE I.

The Effect of Refraction on the Distance between the Moon and the Sun, Fixed Star, or Planet.

| Less Altitude. | Greater Altitude. | APPARENT DISTANCE. | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 55° | 60° | 65° | 70° | 75° | 80° | 85° | 90° | 95° | 100° | 105° | 110° | 115° | 120° |
| ° | ° | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ″ | ′ ″ | ′ ″ | ″ | ′ ′ |
| 32 | 32 | 0.20 | 0.25 | 0.30 | 0.36 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 6 | 1.13 | 1.20 | 1.28 | 1.36 | 1.44 | 1.54 | 2. 4 | 2.15 | 2.28 | 2.42 | 2.59 | 3.16 |
| | 35 | 0.21 | 0.26 | 0.31 | 0.36 | 0.42 | 0.47 | 0.54 | 0.59 | 1. 7 | 1.13 | 1.20 | 1.28 | 1.36 | 1.45 | 1.54 | 2. 5 | 2.16 | 2.28 | 2.42 | 2.59 | |
| | 40 | 0.26 | 0.31 | 0.35 | 0.39 | 0.44 | 0.50 | 0.56 | 1. 2 | 1. 9 | 1.15 | 1.22 | 1.30 | 1.38 | 1.47 | 1.56 | 2. 7 | 2.18 | 2.30 | 2.44 | | |
| | 45 | 0 34 | 0.37 | 0.40 | 0.44 | 0.49 | 0.54 | 1. 0 | 1. 5 | 1.12 | 1.18 | 1.25 | 1.33 | 1.40 | 1.49 | 1.59 | 2. 9 | 2.20 | 2.33 | | | |
| | 50 | 0.42 | 0.43 | 0.46 | 0.49 | 0 53 | 0.58 | 1. 4 | 1. 8 | 1.15 | 1.21 | 1.28 | 1.36 | 1.43 | 1.52 | 2. 1 | 2.12 | 2.23 | | | | |
| | 55 | 0.51 | 0.50 | 0.52 | 0.54 | 0.58 | 1. 2 | 1. 8 | 1.12 | 1.19 | 1.24 | 1.31 | 1.39 | 1.46 | 1.55 | 2. 4 | 2.15 | | | | | |
| | 60 | . | 0.58 | 0.58 | 1. 0 | 1. 3 | 1. 7 | 1.12 | 1.16 | 1.23 | 1.28 | 1.35 | 1.42 | 1.50 | 1.58 | 2. 8 | | | | | | |
| | 65 | . | . | 1. 4 | 1. 5 | 1. 7 | 1.11 | 1.15 | 1.19 | 1.26 | 1.31 | 1.38 | 1.45 | 1.53 | 2. 1 | | | | | | | |
| | 70 | . | . | . | 1. 8 | 1.10 | 1.14 | 1.18 | 1.22 | 1.28 | 1.33 | 1.40 | 1.47 | 1.55 | | | | | | | | |
| | 75 | . | . | . | . | 1.13 | 1.16 | 1.21 | 1.24 | 1.30 | 1.35 | 1.42 | 1.49 | | | | | | | | | |
| | 80 | . | . | . | . | . | 1.18 | 1.23 | 1.26 | 1.32 | 1.37 | 1.44 | | | | | | | | | | |
| 33 | 33 | 0.20 | 0.25 | 0.30 | 0 36 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 6 | 1.13 | 1.20 | 1.28 | 1.36 | 1.44 | 1 54 | 2. 4 | 2.15 | 2.28 | 2.42 | 2.59 | 3.16 |
| | 35 | 0.20 | 0.26 | 0.31 | 0.36 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 7 | 1.13 | 1.20 | 1.28 | 1.36 | 1.44 | 1.54 | 2. 4 | 2.16 | 2.28 | 2.42 | 2.59 | |
| | 40 | 0.25 | 0.29 | 0.34 | 0.38 | 0.44 | 0.49 | 0.56 | 1. 1 | 1. 8 | 1.14 | 1.22 | 1.29 | 1.37 | 1.46 | 1.55 | 2. 6 | 2.17 | 2.29 | 2.44 | | |
| | 45 | 0.31 | 0.35 | 0.39 | 0.42 | 0.47 | 0.52 | 0.59 | 1. 4 | 1.11 | 1.17 | 1.24 | 1.32 | 1.40 | 1.48 | 1.58 | 2. 8 | 2.20 | 2.32 | | | |
| | 50 | 0.39 | 0.41 | 0.44 | 0.47 | 0.51 | 0 56 | 1. 2 | 1. 7 | 1.14 | 1.20 | 1.27 | 1.35 | 1.42 | 1.51 | 2. 0 | 2.11 | 2.22 | | | | |
| | 55 | 0.47 | 0.47 | 0.49 | 0.52 | 0.56 | 1. 0 | 1. 6 | 1.10 | 1.17 | 1.23 | 1 30 | 1.37 | 1.45 | 1.54 | 2. 3 | 2.14 | | | | | |
| | 60 | . | 0.55 | 0.56 | 0.57 | 1. 1 | 1. 5 | 1.10 | 1.14 | 1.21 | 1.26 | 1.33 | 1.41 | 1.48 | 1.57 | 2. 6 | | | | | | |
| | 65 | . | . | 1. 1 | 1. 2 | 1. 4 | 1. 8 | 1.13 | 1.17 | 1.24 | 1.29 | 1 36 | 1.43 | 1.51 | 1.59 | | | | | | | |
| | 70 | . | . | . | 1. 5 | 1. 8 | 1.11 | 1.16 | 1.20 | 1.26 | 1.31 | 1.38 | 1.46 | 1.53 | | | | | | | | |
| | 75 | . | . | . | . | 1.11 | 1.14 | 1 18 | 1.22 | 1.28 | 1.33 | 1.40 | 1.47 | | | | | | | | | |
| | 80 | . | . | . | . | . | 1.16 | 1.20 | 1.24 | 1.30 | 1.35 | 1.42 | | | | | | | | | | |
| 34 | 34 | 0.20 | 0.26 | 0.30 | 0.36 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 6 | 1.13 | 1.20 | 1.28 | 1 36 | 1.44 | 1.54 | 2. 4 | 2.15 | 2.28 | 2.42 | | |
| | 35 | 0.20 | 0.26 | 0.30 | 0.36 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 6 | 1.13 | 1.20 | 1.28 | 1.36 | 1.44 | 1.54 | 2 4 | 2.15 | 2 28 | 2.43 | | |
| | 40 | 0 23 | 0.28 | 0.33 | 0.38 | 0.42 | 0.48 | 0.57 | 1. 1 | 1. 7 | 1.14 | 1.22 | 1.30 | 1.38 | 1.46 | 1.56 | 2. 7 | 2.17 | 2.30 | | | |
| | 45 | 0.30 | 0.33 | 0.36 | 0.42 | 0.46 | 0.52 | 0.59 | 1. 3 | 1. 9 | 1.16 | 1.24 | 1.32 | 1.40 | 1.48 | 1.58 | 2. 8 | 2.19 | | | | |
| | 50 | 0.35 | 0.39 | 0.41 | 0.46 | 0.50 | 0.55 | 1. 2 | 1. 6 | 1.11 | 1.18 | 1.26 | 1.34 | 1.42 | 1.51 | 2. 0 | 2.10 | | | | | |
| | 55 | 0.44 | 0.45 | 0.46 | 0.51 | 0.53 | 0.59 | 1. 6 | 1. 9 | 1.15 | 1.21 | 1.29 | 1.36 | 1.44 | 1.54 | 2. 2 | | | | | | |
| | 60 | . | 0.52 | 0.53 | 0.56 | 0.58 | 1. 2 | 1.10 | 1.13 | 1.18 | 1.24 | 1.32 | 1.39 | 1.46 | 1.56 | | | | | | | |
| | 65 | . | . | 0.57 | 1. 0 | 1. 1 | 1. 6 | 1.13 | 1.15 | 1.21 | 1.27 | 1.34 | 1.42 | 1.49 | | | | | | | | |
| | 70 | . | . | . | 1. 3 | 1. 4 | 1.10 | 1.15 | 1.18 | 1.23 | 1.29 | 1.36 | 1.44 | | | | | | | | | |
| | 75 | . | . | . | . | 1. 6 | 1.13 | 1.17 | 1.21 | 1.26 | 1.31 | 1.37 | | | | | | | | | | |
| | 80 | . | . | . | . | . | 1.14 | 1.19 | 1.23 | 1.28 | 1.32 | | | | | | | | | | | |
| 35 | 35 | 0 20 | 0.26 | 0.30 | 0.36 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 6 | 1.13 | 1 20 | 1.28 | 1 36 | 1.44 | 1.54 | 2. 4 | 2.15 | 2.28 | 2.42 | | |
| | 40 | 0.22 | 0.27 | 0.32 | 0.37 | 0.43 | 0.48 | 0 55 | 1. 0 | 1. 7 | 1 14 | 1.21 | 1.29 | 1 36 | 1.45 | 1 55 | 2 .5 | 2.16 | 2.29 | | | |
| | 45 | 0 28 | 0.32 | 0.36 | 0.40 | 0.46 | 0.51 | 0.57 | 1. 2 | 1.10 | 1.16 | 1.23 | 1.31 | 1.38 | 1.47 | 1.56 | 2 .7 | 2.18 | | | | |
| | 50 | 0.34 | 0.36 | 0.40 | 0.44 | 0 50 | 0 54 | 1. 0 | 1. 5 | 1 12 | 1.18 | 1 25 | 1 33 | 1.40 | 1.49 | 1.59 | 2. 9 | | | | | |
| | 55 | 0.41 | 0.41 | 0.45 | 0.48 | 0.53 | 0.57 | 1. 3 | 1. 8 | 1.15 | 1.20 | 1.28 | 1.35 | 1.43 | 1.51 | 2. 1 | | | | | | |
| | 60 | . | 0.48 | 0.51 | 0.53 | 0.58 | 1. 1 | 1. 7 | 1.11 | 1.17 | 1.23 | 1.31 | 1 38 | 1.46 | 1.54 | | | | | | | |
| | 65 | . | . | 0.55 | 0.57 | 1. 1 | 1. 4 | 1.10 | 1.14 | 1.20 | 1.26 | 1 35 | 1.40 | 1.48 | | | | | | | | |
| | 70 | . | . | . | 1. 0 | 1. 4 | 1. 7 | 1.12 | 1.16 | 1.23 | 1.28 | 1.35 | 1.42 | | | | | | | | | |
| | 75 | . | . | . | . | 1. 6 | 1. 9 | 1.14 | 1.18 | 1.24 | 1.30 | 1.37 | | | | | | | | | | |
| | 80 | . | . | . | . | | 1.11 | 1.16 | 1.20 | 1.26 | 1.31 | | | | | | | | | | | |
| 36 | 36 | 0.20 | 0.25 | 0.30 | 0.36 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 6 | 1.13 | 1.20 | 1 28 | 1.36 | 1 44 | 1.54 | 2. 4 | 2.16 | 2 28 | 2.42 | | |
| | 40 | 0.20 | 0.25 | 0.31 | 0.37 | 0.41 | 0.48 | 0.56 | 1. 0 | 1. 6 | 1.13 | 1.21 | 1.29 | 1 36 | 1 46 | 1.56 | 2. 6 | 2.17 | 2.28 | | | |
| | 45 | 0.25 | 0.29 | 0.34 | 0.40 | 0.44 | 0.51 | 0.58 | 1. 2 | 1. 7 | 1.14 | 1.22 | 1.31 | 1.38 | 1.47 | 1.57 | 2. 7 | 2.18 | | | | |
| | 50 | 0.30 | 0.33 | 0.37 | 0.44 | 0.47 | 0.54 | 1. 0 | 1. 4 | 1.10 | 1.16 | 1.2[illegible] | 1 32 | 1.40 | 1.49 | 1.58 | 2. 9 | | | | | |
| | 55 | 0.38 | 0.38 | 0.42 | 0.47 | 0.50 | 0.56 | 1. 3 | 1. 7 | 1.13 | 1.18 | 1.27 | 1.34 | 1.42 | 1.51 | 2. 0 | | | | | | |
| | 60 | 0.48 | 0.44 | 0.47 | 0.51 | 0.55 | 0.59 | 1. 6 | 1.10 | 1.15 | 1.20 | 1.30 | 1.36 | 1.44 | 1.53 | | | | | | | |
| | 65 | . | 0.53 | 0.52 | 0.54 | 0.59 | 1. 2 | 1. 9 | 1.12 | 1.18 | 1.23 | 1.32 | 1.38 | 1.46 | | | | | | | | |
| | 70 | . | . | 0.57 | 0.57 | 1. 2 | 1. 5 | 1.11 | 1.14 | 1.20 | 1 26 | 1.33 | 1.40 | | | | | | | | | |
| | 75 | . | . | . | 1. 0 | 1. 4 | 1. 7 | 1.13 | 1 16 | 1.21 | 1.27 | 1.34 | | | | | | | | | | |
| | 80 | . | . | . | . | 1. 6 | 1. 9 | 1.14 | 1.19 | 1.23 | 1.29 | | | | | | | | | | | |
| 37 | 37 | 0.20 | 0.25 | 0.30 | 0.36 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 6 | 1.13 | 1.20 | 1.28 | 1.36 | 1.44 | 1.54 | 2. 4 | 2.15 | .28 | 2.42 | | |
| | 40 | 0.22 | 0.26 | 0.31 | 0 37 | 0.43 | 0.49 | 0.54 | 0.59 | 1. 7 | 1.13 | 1.21 | 1.28 | 1.36 | 1.45 | 1 54 | 2. 5 | 2.16 | 2.28 | | | |
| | 45 | 0.26 | 0.29 | 0.34 | 0.39 | 0.45 | 0.50 | 0.56 | 1. 1 | 1. 8 | 1.14 | 1.22 | 1.30 | 1.37 | 1 46 | 1.56 | 2. 6 | 2.17 | | | | |
| | 50 | 0.31 | 0 33 | 0.37 | 0.42 | 0.47 | 0.53 | 0.58 | 1. 3 | 1.10 | 1.16 | 1.24 | 1.31 | 1.39 | 1.48 | 1.57 | 2. 8 | | | | | |
| | 55 | 0.37 | 0.38 | 0.41 | 0.46 | 0 50 | 0.56 | 1. 1 | 1. 5 | 1.13 | 1.19 | 1.26 | 1.33 | 1.41 | 1.50 | 1.59 | | | | | | |
| | 60 | 0.44 | 0.44 | 0.47 | 0.50 | 0.54 | 0.59 | 1. 4 | 1. 9 | 1.16 | 1.21 | 1.29 | 1.36 | 1.44 | 1.52 | | | | | | | |
| | 65 | . | 0.49 | 0.50 | 0.54 | 0.56 | 1. 2 | 1. 6 | 1.11 | 1.18 | 1.24 | 1.31 | 1.38 | 1.46 | | | | | | | | |
| | 70 | | . | 0.54 | 0.56 | 1. 0 | 1. 4 | 1. 9 | 1.13 | 1.20 | 1.25 | 1 32 | 1.40 | | | | | | | | | |
| | 75 | . | . | . | 0.59 | 1. 2 | 1. 6 | 1.10 | 1.15 | 1 21 | 1.27 | 1.34 | | | | | | | | | | |
| | 80 | . | . | . | . | 1. 4 | 1. 8 | 1.12 | 1.16 | 1.23 | 1.28 | | | | | | | | | | | |

# TABLES I. & II.

## The Effect of Refraction on the Distance between the Moon and the Sun, Fixed Star, or Planet.

| Less Altitude. | Greater Altitude. | APPARENT DISTANCE. | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 55° | 60° | 65° | 70° | 75° | 80° | 85° | 90° | 95° | 100° | 105° | 110° | 115° | 120° |
| ° | ° | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ |
| 38 | 38 | 0.20 | 0.25 | 0.30 | 0.35 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 6 | 1.13 | 1.20 | 1.28 | 1.36 | 1.44 | 1.54 | 2. 4 | 2.16 | 2.28 | 2.42 | | |
| | 40 | 0.20 | 0.25 | 0.30 | 0.36 | 0.41 | 0.47 | 0.54 | 1. 0 | 1. 6 | 1.13 | 1.20 | 1.29 | 1.36 | 1.45 | 1.55 | 2. 5 | 2.16 | 2.28 | | | |
| | 45 | 0.23 | 0 29 | 0.33 | 0.39 | 0.42 | 0.49 | 0.58 | 1. 1 | 1. 7 | 1.13 | 1.22 | 1.30 | 1.38 | 1.47 | 1.56 | 2. 6 | 2.17 | | | | |
| | 50 | 0.27 | 0.33 | 0.36 | 0.42 | 0.45 | 0.52 | 0.59 | 1. 3 | 1. 9 | 1.15 | 1.23 | 1.32 | 1.40 | 1.48 | 1.58 | 2. 7 | | | | | |
| | 55 | 0.34 | 0.37 | 0.40 | 0.45 | 0.48 | 0.54 | 1. 1 | 1. 5 | 1.11 | 1.16 | 1.25 | 1.33 | 1 41 | 1.49 | 1.59 | | | | | | |
| | 60 | 0.40 | 0.43 | 0.44 | 0.49 | 0.51 | 0.57 | 1. 3 | 1. 7 | 1.13 | 1.18 | 1.27 | 1.34 | 1.43 | 1.51 | | | | | | | |
| | 65 | . | 0,47 | 0.48 | 0.52 | 0.54 | 1. 0 | 1. 5 | 1. 9 | 1.16 | 1.21 | 1.29 | 1.36 | 1.45 | | | | | | | | |
| | 70 | . | . | 0.51 | 0.55 | 0.58 | 1. 2 | 1. 8 | 1.12 | 1.18 | 1.23 | 1.31 | 1.39 | | | | | | | | | |
| | 75 | . | . | . | 0.57 | 1. 0 | 1. 4 | 1.11 | 1.14 | 1.19 | 1.25 | 1.32 | | | | | | | | | | |
| | 80 | . | . | . | . | 1. 2 | 1. 6 | 1.12 | 1.16 | 1.21 | 1.27 | | | | | | | | | | | |
| 39 | 39 | 0.20 | 0.25 | 0.30 | 0.36 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 6 | 1.13 | 1.20 | 1.28 | 1.36 | 1.44 | 1.54 | 2. 4 | 2.16 | 2.28 | 2.42 | | |
| | 40 | 0 20 | 0.25 | 0.31 | 0.37 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 6 | 1.13 | 1.20 | 1.28 | 1.36 | 1.44 | 1.54 | 2. 4 | 2.16 | 2.28 | | | |
| | 45 | 0.23 | 0.27 | 0.33 | 0.38 | 0.43 | 0.48 | 0.55 | 1. 0 | 1. 7 | 1.14 | 1.21 | 1.29 | 1.37 | 1.45 | 1.55 | 2. 5 | 2.16 | | | | |
| | 50 | 0.26 | 0.30 | 0.35 | 0.40 | 0.44 | 0.50 | 0.56 | 1. 2 | 1. 8 | 1.15 | 1.22 | 1.30 | 1.38 | 1.46 | 1.56 | 2. 6 | | | | | |
| | 55 | 0.31 | 0.33 | 0.38 | 0.43 | 0.47 | 0.52 | 0.59 | 1. 4 | 1.10 | 1.17 | 1.24 | 1.32 | 1.39 | 1.48 | 1.58 | | | | | | |
| | 60 | 0.38 | 0 39 | 0.43 | 0.47 | 0.51 | 0.56 | 1. 2 | 1. 6 | 1.13 | 1.19 | 1.27 | 1.34 | 1.42 | 1.49 | | | | | | | |
| | 65 | . | 0.43 | 0.46 | 0.50 | 0.53 | 0.58 | 1. 4 | 1. 8 | 1.14 | 1.21 | 1.28 | 1.36 | 1.43 | | | | | | | | |
| | 70 | . | . | 0.49 | 0.52 | 0.55 | 1. 0 | 1. 6 | 1.10 | 1.16 | 1.23 | 1.30 | 1.37 | | | | | | | | | |
| | 75 | . | . | . | 0.54 | 0.57 | 1. 2 | 1. 7 | 1.12 | 1.17 | 1.24 | 1.32 | | | | | | | | | | |
| | 80 | . | . | . | . | 0.59 | 1. 3 | 1. 9 | 1.13 | 1.19 | 1.25 | | | | | | | | | | | |
| 40 | 40 | 0.20 | 0.26 | 0.31 | 0.36 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 7 | 1.13 | 1.20 | 1.28 | 1.36 | 1.44 | 1.54 | 2. 5 | 2.16 | | | | |
| | 45 | 0.22 | 0.27 | 0.32 | 0.37 | 0.42 | 0.48 | 0.54 | 1. 0 | 1. 7 | 1.13 | 1.21 | 1.28 | 1.36 | 1.45 | 1.54 | 2. 5 | | | | | |
| | 50 | 0.25 | 0.29 | 0.34 | 0.38 | 0.44 | 0.49 | 0 56 | 1. 1 | 1. 8 | 1.14 | 1.22 | 1.29 | 1.37 | 1.46 | 1.56 | | | | | | |
| | 55 | 0.29 | 0.33 | 0.37 | 0.41 | 0.46 | 0.51 | 0.58 | 1. 3 | 1.10 | 1.16 | 1.25 | 1.31 | 1.39 | 1.48 | | | | | | | |
| | 60 | 0.35 | 0.38 | 0.41 | 0.45 | 0.49 | 0 55 | 1. 0 | 1. 5 | 1.13 | 1.18 | 1.26 | 1.33 | 1.41 | | | | | | | | |
| | 65 | . | 0.42 | 0.44 | 0.47 | 0.52 | 0.57 | 1. 2 | 1. 7 | 1.14 | 1.20 | 1.28 | 1.34 | | | | | | | | | |
| | 70 | . | . | 0.47 | 0.50 | 0.54 | 0.59 | 1. 4 | 1. 9 | 1.16 | 1.22 | 1.29 | | | | | | | | | | |
| | 75 | . | . | . | 0.53 | 0.56 | 1. 0 | 1. 6 | 1.10 | 1.17 | 1.23 | | | | | | | | | | | |
| | 80 | . | . | . | . | 0.58 | 1. 2 | 1. 7 | 1.12 | 1.18 | | | | | | | | | | | | |
| 42 | 42 | 0.20 | 0.25 | 0.30 | 0.36 | 0.41 | 0.47 | 0.54 | 0 59 | 1. 6 | 1.13 | 1.20 | 1.28 | 1.36 | 1.44 | 1.54 | 2. 5 | 2.16 | | | | |
| | 45 | 0.21 | 0.26 | 0.31 | 0.37 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 6 | 1.13 | 1.20 | 1.28 | 1.36 | 1.45 | 1.54 | 2. 6 | | | | | |
| | 50 | 0.23 | 0.28 | 0.33 | 0.38 | 0.43 | 0.48 | 0.55 | 1. 0 | 1. 7 | 1.14 | 1.21 | 1.29 | 1.37 | 1.45 | 1.55 | | | | | | |
| | 55 | 0.26 | 0.30 | 0.35 | 0.40 | 0.44 | 0.50 | 0.56 | 1. 1 | 1. 8 | 1.15 | 1.22 | 1.30 | 1.38 | 1.46 | | | | | | | |
| | 60 | 0.32 | 0.35 | 0.39 | 0.43 | 0.48 | 0.53 | 0 59 | 1. 4 | 1.10 | 1.17 | 1.25 | 1.32 | 1.40 | | | | | | | | |
| | 65 | 0.36 | 0.38 | 0 42 | 0.46 | 0.50 | 0.55 | 1. 1 | 1. 6 | 1.12 | 1.19 | 1.26 | 1 33 | | | | | | | | | |
| | 70 | . | 0.41 | 0.44 | 0.48 | 0.51 | 0.56 | 1. 2 | 1. 7 | 1.13 | 1.20 | 1.27 | | | | | | | | | | |
| | 75 | . | . | 0.46 | 0.49 | 0.53 | 0.57 | 1. 3 | 1. 8 | 1.14 | 1.21 | | | | | | | | | | | |
| | 80 | . | . | . | 0.51 | 0.55 | 0.59 | 1. 5 | 1. 9 | 1.15 | | | | | | | | | | | | |
| 45 | 45 | 0.20 | 0.26 | 0.31 | 0.36 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 7 | 1.13 | 1.20 | 1.28 | 1 36 | 1.44 | 1.54 | | | | | | |
| | 50 | 0 21 | 0.26 | 0.31 | 0.36 | 0.42 | 0.47 | 0.54 | 0.59 | 1. 7 | 1.13 | 1.20 | 1.28 | 1.36 | 1.45 | | | | | | | |
| | 60 | 0.27 | 0.31 | 0.35 | 0.40 | 0.45 | 0.50 | 0.57 | 1. 2 | 1. 9 | 1.15 | 1.23 | 1.30 | 1.38 | | | | | | | | |
| | 70 | 0.33 | 0.36 | 0.40 | 0.43 | 0.48 | 0.53 | 1. 0 | 1. 5 | 1.12 | 1.18 | 1.25 | | | | | | | | | | |
| | 80 | . | . | 0.43 | 0.46 | 0.51 | 0.56 | 1. 2 | 1. 7 | 1.14 | | | | | | | | | | | | |
| 50 | 50 | 0.20 | 0.26 | 0.31 | 0.36 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 7 | 1.13 | 1.20 | 1.28 | 1.36 | | | | | | | | |
| | 60 | 0.22 | 0.27 | 0 31 | 0.37 | 0.41 | 0 48 | 0.55 | 0.59 | 1. 7 | 1.13 | 1.20 | 1.28 | | | | | | | | | |
| | 70 | 0.27 | 0.30 | 0 34 | 0.39 | 0.44 | 0.50 | 0.56 | 1. 1 | 1. 9 | 1.15 | 1.22 | | | | | | | | | | |
| | 80 | . | 0 33 | 0.37 | 0.41 | 0.46 | 0.52 | 0.58 | 1. 3 | 1.10 | | | | | | | | | | | | |
| 55 | 55 | 0.20 | 0.26 | 0.31 | 0.36 | 0.41 | 0.47 | 0.54 | 0.59 | 1. 6 | 1.13 | 1.20 | | | | | | | | | | |
| | 60 | 0.20 | 0.26 | 0.31 | 0.38 | 0.41 | 0.48 | 0.54 | 0.59 | 1. 6 | 1.13 | | | | | | | | | | | |
| | 70 | 0.22 | 0,28 | 0.33 | 0 39 | 0.43 | 0.49 | 0.54 | 1. 1 | 1. 6 | | | | | | | | | | | | |
| | 80 | 0.26 | 0.30 | 0.34 | 0.39 | 0.44 | 0.49 | 0.55 | 1. 2 | | | | | | | | | | | | | |

## TABLE II.

Diff. in 5° of Distance, or Greater Altitude.

| Odd °'s of Dist. & Alt. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 |
| 2 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 4 | 5 | 5 |
| 3 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 5 | 6 | 7 | 7 | 8 |
| 4 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 8 | 9 | 10 | 10 |

| Odd °'s of Dist.& Alt. | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 46 | 48 | 50 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 1 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 10 | 10 |
| 2 | 6 | 6 | 6 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 14 | 14 | 14 | 15 | 15 | 16 | 16 | 16 | 17 | 17 | 18 | 18 | 19 | 20 |
| 3 | 8 | 9 | 10 | 10 | 11 | 11 | 12 | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 17 | 17 | 18 | 19 | 19 | 20 | 20 | 21 | 22 | 22 | 23 | 23 | 24 | 25 | 25 | 26 | 26 | 28 | 29 | 30 |
| 4 | 11 | 12 | 13 | 14 | 14 | 15 | 16 | 17 | 18 | 18 | 19 | 20 | 21 | 22 | 22 | 23 | 24 | 25 | 26 | 26 | 27 | 28 | 29 | 30 | 30 | 31 | 32 | 33 | 34 | 34 | 35 | 37 | 38 | 40 |

# TABLES III. & IV.

TABLE IV.—For computing the final effect of Parallax on the Moon's Distance from the Sun, or a Star.

## TABLE III.
### The Moon's Parallax in Altitude.

| ☽'s App. Alt. | The Moon's Horizontal Parallax. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | 62′ |
| ° | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ |
| 0 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 |
| 5 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 |
| 10 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 |
| 15 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 18 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 |
| 20 | 50 | 51 | 52 | 53 | 54 | 54 | 55 | 56 | 57 | 58 |
| 22 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 56 | 57 |
| 24 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 |
| 26 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 |
| 28 | 47 | 48 | 49 | 49 | 50 | 51 | 52 | 53 | 54 | 55 |
| 30 | 46 | 47 | 48 | 48 | 49 | 50 | 51 | 52 | 53 | 54 |
| 32 | 45 | 46 | 47 | 47 | 48 | 49 | 50 | 51 | 52 | 53 |
| 34 | 44 | 45 | 46 | 46 | 47 | 48 | 49 | 50 | 51 | 52 |
| 36 | 43 | 44 | 44 | 45 | 46 | 47 | 48 | 48 | 49 | 50 |
| 38 | 42 | 43 | 43 | 44 | 45 | 46 | 46 | 47 | 48 | 49 |
| 40 | 40 | 41 | 42 | 43 | 44 | 44 | 45 | 46 | 47 | 48 |
| 42 | 39 | 40 | 41 | 42 | 42 | 43 | 44 | 45 | 45 | 46 |
| 44 | 38 | 39 | 40 | 40 | 41 | 42 | 42 | 43 | 44 | 45 |
| 46 | 36 | 37 | 38 | 39 | 40 | 40 | 41 | 42 | 42 | 43 |
| 48 | 35 | 36 | 37 | 37 | 38 | 39 | 39 | 40 | 41 | 42 |
| 50 | 34 | 35 | 35 | 36 | 37 | 37 | 38 | 39 | 39 | 40 |
| 51 | 33 | 34 | 35 | 35 | 36 | 36 | 37 | 38 | 38 | 39 |
| 52 | 32 | 33 | 34 | 34 | 35 | 36 | 36 | 37 | 38 | 39 |
| 53 | 31 | 32 | 33 | 34 | 34 | 35 | 35 | 36 | 37 | 38 |
| 54 | 31 | 32 | 32 | 33 | 33 | 34 | 35 | 35 | 36 | 37 |
| 55 | 30 | 31 | 31 | 32 | 33 | 33 | 34 | 34 | 35 | 36 |
| 56 | 29 | 30 | 31 | 31 | 32 | 32 | 33 | 34 | 34 | 35 |
| 57 | 28 | 29 | 30 | 30 | 31 | 32 | 32 | 33 | 33 | 34 |
| 58 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 32 | 32 | 33 |
| 59 | 27 | 28 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 32 |
| 60 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 30 | 30 |
| 61 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 30 |
| 62 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 29 |
| 63 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 |
| 64 | 24 | 24 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 27 |
| 65 | 23 | 23 | 23 | 24 | 24 | 24 | 25 | 25 | 26 | 26 |
| 66 | 22 | 22 | 22 | 23 | 23 | 24 | 24 | 24 | 25 | 25 |
| 67 | 21 | 21 | 21 | 22 | 22 | 23 | 23 | 23 | 24 | 24 |
| 68 | 20 | 20 | 21 | 21 | 21 | 22 | 22 | 22 | 23 | 23 |
| 69 | 19 | 19 | 20 | 20 | 20 | 21 | 21 | 21 | 22 | 22 |
| 70 | 18 | 18 | 19 | 19 | 19 | 20 | 20 | 20 | 21 | 21 |
| 71 | 18 | 18 | 18 | 18 | 19 | 19 | 19 | 19 | 20 | 20 |
| 72 | 17 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 19 | 19 |
| 73 | 16 | 16 | 16 | 16 | 17 | 17 | 17 | 17 | 18 | 18 |
| 74 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 16 | 17 | 17 |
| 75 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 16 | 16 |
| 76 | 13 | 13 | 13 | 14 | 14 | 14 | 14 | 14 | 15 | 15 |
| 77 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 14 | 14 |
| 78 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 12 | 13 | 13 |
| 79 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 12 | 12 |
| 80 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 11 | 11 |
| 81 | 8 | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 10 | 10 |
| 82 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 9 |
| 83 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 8 |
| 84 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 |
| 85 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 86 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 87 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 88 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 89 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## TABLE IV.

APPARENT DISTANCE.

Add the Difference of the two Numbers taken out of this Table, if the Apparent Distance is less than 90°, and subtract it if above.

| Par. in Alt. or Distance | 20° | 21° | 22° | 23° | 24° | 25° | 26° | 27° | 28° | 29° | 30° | 31° | 32° | 33° | 34° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ′ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 5 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 10 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| 11 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 12 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 13 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| 14 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 15 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 |
| 16 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 |
| 17 | 7 | 7 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 |
| 18 | 8 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 5 | 4 | 4 |
| 19 | 9 | 8 | 8 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 5 |
| 20 | 10 | 9 | 9 | 8 | 8 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 5 | 5 |
| 21 | 11 | 10 | 10 | 9 | 9 | 8 | 8 | 8 | 7 | 7 | 7 | 6 | 6 | 6 | 6 |
| 22 | 12 | 11 | 10 | 10 | 9 | 9 | 9 | 8 | 8 | 8 | 7 | 7 | 7 | 7 | 6 |
| 23 | 13 | 12 | 11 | 11 | 10 | 10 | 9 | 9 | 9 | 8 | 8 | 8 | 7 | 7 | 7 |
| 24 | 14 | 13 | 12 | 12 | 11 | 11 | 10 | 10 | 9 | 9 | 9 | 8 | 8 | 8 | 7 |
| 25 | 15 | 14 | 13 | 13 | 12 | 12 | 11 | 11 | 10 | 10 | 9 | 9 | 9 | 8 | 8 |
| 26 | 16 | 15 | 15 | 14 | 13 | 13 | 12 | 12 | 11 | 11 | 10 | 10 | 9 | 9 | 9 |
| 27 | 17 | 17 | 16 | 15 | 14 | 14 | 13 | 12 | 12 | 11 | 11 | 11 | 10 | 10 | 9 |
| 28 | 19 | 18 | 17 | 16 | 15 | 15 | 14 | 13 | 13 | 12 | 12 | 11 | 11 | 11 | 10 |
| 29 | 20 | 19 | 18 | 17 | 16 | 16 | 15 | 14 | 14 | 13 | 13 | 12 | 12 | 11 | 11 |
| 30 | 22 | 20 | 19 | 19 | 18 | 17 | 16 | 15 | 15 | 14 | 14 | 13 | 13 | 12 | 12 |
| 31 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 16 | 15 | 15 | 14 | 13 | 13 | 12 |
| 32 | 25 | 23 | 22 | 21 | 20 | 19 | 18 | 18 | 17 | 16 | 15 | 15 | 14 | 14 | 13 |
| 33 | 26 | 25 | 24 | 22 | 21 | 20 | 19 | 19 | 18 | 17 | 16 | 16 | 15 | 15 | 14 |
| 34 | 28 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 17 | 16 | 16 | 15 |
| 35 | 29 | 28 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 19 | 18 | 17 | 16 | 16 |
| 36 | 31 | 29 | 28 | 27 | 25 | 24 | 23 | 22 | 21 | 20 | 20 | 19 | 18 | 17 | 17 |
| 37 | 33 | 31 | 30 | 28 | 27 | 26 | 24 | 23 | 22 | 22 | 21 | 20 | 19 | 18 | 18 |
| 38 | 35 | 33 | 31 | 30 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 19 |
| 39 | 36 | 35 | 33 | 31 | 30 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 20 |
| 40 | 38 | 36 | 35 | 33 | 31 | 30 | 29 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 21 |
| 41 | 40 | 38 | 36 | 35 | 33 | 31 | 30 | 29 | 28 | 26 | 25 | 24 | 23 | 23 | 22 |
| 42 | 42 | 40 | 38 | 36 | 35 | 33 | 32 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 |
| 43 | 44 | 42 | 40 | 38 | 36 | 35 | 33 | 32 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
| 44 | 46 | 44 | 42 | 40 | 38 | 36 | 35 | 33 | 32 | 30 | 29 | 28 | 27 | 26 | 25 |
| 45 | 49 | 46 | 44 | 42 | 40 | 38 | 36 | 35 | 33 | 32 | 31 | 29 | 28 | 27 | 26 |
| 46 | 51 | 48 | 46 | 43 | 41 | 40 | 38 | 36 | 35 | 33 | 32 | 31 | 30 | 28 | 27 |
| 47 | 53 | 50 | 48 | 45 | 43 | 41 | 40 | 38 | 36 | 35 | 33 | 32 | 31 | 30 | 29 |
| 48 | 55 | 52 | 50 | 47 | 45 | 43 | 41 | 39 | 38 | 36 | 35 | 33 | 32 | 31 | 30 |
| 49 | 58 | 55 | 52 | 49 | 47 | 45 | 43 | 41 | 39 | 38 | 36 | 35 | 34 | 32 | 31 |
| 50 | 60 | 57 | 54 | 51 | 49 | 47 | 45 | 43 | 41 | 39 | 38 | 36 | 35 | 34 | 32 |
| 51 | 62 | 59 | 56 | 53 | 51 | 49 | 47 | 45 | 43 | 41 | 39 | 38 | 36 | 35 | 34 |
| 52 | 65 | 61 | 58 | 56 | 53 | 51 | 48 | 46 | 44 | 43 | 41 | 39 | 38 | 36 | 35 |
| 53 | 67 | 64 | 61 | 58 | 55 | 53 | 50 | 48 | 46 | 44 | 42 | 41 | 39 | 38 | 36 |
| 54 | 70 | 66 | 63 | 60 | 57 | 55 | 52 | 50 | 48 | 46 | 44 | 42 | 41 | 39 | 38 |
| 55 | 72 | 69 | 65 | 62 | 59 | 57 | 54 | 52 | 50 | 48 | 46 | 44 | 42 | 41 | 39 |
| 56 | 75 | 71 | 68 | 64 | 61 | 59 | 56 | 54 | 51 | 49 | 47 | 46 | 44 | 42 | 41 |
| 57 | 78 | 74 | 70 | 67 | 64 | 61 | 58 | 56 | 53 | 51 | 49 | 47 | 45 | 44 | 42 |
| 58 | 81 | 76 | 73 | 69 | 66 | 63 | 60 | 58 | 55 | 53 | 51 | 49 | 47 | 45 | 44 |
| 59 | 83 | 79 | 75 | 72 | 68 | 65 | 62 | 60 | 57 | 55 | 53 | 51 | 49 | 47 | 45 |
| 60 | 86 | 82 | 78 | 74 | 71 | 67 | 64 | 62 | 59 | 57 | 54 | 52 | 50 | 48 | 47 |
| 61 | 89 | 85 | 80 | 76 | 73 | 70 | 67 | 64 | 61 | 59 | 56 | 54 | 52 | 50 | 48 |
| 62 | 92 | 87 | 83 | 79 | 75 | 72 | 69 | 66 | 63 | 60 | 58 | 56 | 54 | 52 | 50 |
| ′ | 20° | 21° | 22° | 23° | 24° | 25° | 26° | 27° | 28° | 29° | 30° | 31° | 32° | 33° | 34° |

# TABLE IV

## For computing the final effect of Parallax on the Moon's Distance from the Sun, or a Star.

### APPARENT DISTANCE.

Add the Difference of the two Numbers taken out of this Table, if the Apparent Distance is less than 90°, and subtract it if above.

| Par. in Alt. or Distance | | | | | | | | | | | | | | | | | | | 120 | 115 | 110 | 105 | 100 | 95 | 90 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 35° | 36° | 37° | 38° | 39° | 40° | 41° | 42° | 43° | 44° | 45° | 46° | 48° | 50° | 52° | 54° | 56° | 58° | 60° | 65° | 70° | 75° | 80° | 85° | 90° |
| ′ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 13 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 14 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 15 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 16 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 17 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 18 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 |
| 19 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 0 | 0 |
| 20 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 |
| 21 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 |
| 22 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 0 | 0 |
| 23 | 7 | 6 | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 0 | 0 |
| 24 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 0 | 0 |
| 25 | 8 | 8 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 1 | 1 | 0 | 0 |
| 26 | 8 | 8 | 8 | 8 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 2 | 2 | 1 | 1 | 0 |
| 27 | 9 | 9 | 8 | 8 | 8 | 8 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 5 | 5 | 5 | 4 | 4 | 4 | 3 | 2 | 2 | 1 | 1 | 0 |
| 28 | 10 | 9 | 9 | 9 | 8 | 8 | 8 | 8 | 7 | 7 | 7 | 7 | 6 | 6 | 5 | 5 | 5 | 4 | 4 | 3 | 2 | 2 | 1 | 1 | 0 |
| 29 | 10 | 10 | 10 | 9 | 9 | 9 | 8 | 8 | 8 | 8 | 7 | 7 | 7 | 6 | 6 | 5 | 5 | 5 | 4 | 3 | 3 | 2 | 1 | 1 | 0 |
| 30 | 11 | 11 | 10 | 10 | 10 | 9 | 9 | 9 | 8 | 8 | 8 | 8 | 7 | 7 | 6 | 6 | 5 | 5 | 5 | 4 | 3 | 2 | 1 | 1 | 0 |
| 31 | 12 | 12 | 11 | 11 | 10 | 10 | 10 | 9 | 9 | 9 | 8 | 8 | 8 | 7 | 7 | 6 | 6 | 5 | 5 | 4 | 3 | 2 | 1 | 1 | 0 |
| 32 | 13 | 12 | 12 | 11 | 11 | 11 | 10 | 10 | 10 | 9 | 9 | 9 | 8 | 7 | 7 | 6 | 6 | 6 | 5 | 4 | 3 | 2 | 2 | 1 | 0 |
| 33 | 14 | 13 | 13 | 12 | 12 | 11 | 11 | 11 | 10 | 10 | 10 | 9 | 9 | 8 | 7 | 7 | 6 | 6 | 5 | 4 | 3 | 3 | 2 | 1 | 0 |
| 34 | 14 | 14 | 13 | 13 | 12 | 12 | 12 | 11 | 11 | 10 | 10 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 35 | 15 | 15 | 14 | 14 | 13 | 13 | 12 | 12 | 11 | 11 | 11 | 10 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 36 | 16 | 16 | 15 | 14 | 14 | 13 | 13 | 13 | 12 | 12 | 11 | 11 | 10 | 9 | 9 | 8 | 8 | 7 | 7 | 5 | 4 | 3 | 2 | 1 | 0 |
| 37 | 17 | 16 | 16 | 15 | 15 | 14 | 14 | 13 | 13 | 12 | 12 | 12 | 11 | 10 | 9 | 9 | 8 | 7 | 7 | 6 | 4 | 3 | 2 | 1 | 0 |
| 38 | 18 | 17 | 17 | 16 | 16 | 15 | 14 | 14 | 14 | 13 | 13 | 12 | 11 | 11 | 10 | 9 | 8 | 8 | 7 | 6 | 5 | 3 | 2 | 1 | 0 |
| 39 | 19 | 18 | 18 | 17 | 16 | 16 | 15 | 15 | 14 | 14 | 13 | 13 | 12 | 11 | 10 | 10 | 9 | 8 | 8 | 6 | 5 | 4 | 2 | 1 | 0 |
| 40 | 20 | 19 | 19 | 18 | 17 | 17 | 16 | 16 | 15 | 14 | 14 | 13 | 13 | 12 | 11 | 10 | 9 | 9 | 8 | 7 | 5 | 4 | 2 | 1 | 0 |
| 41 | 21 | 20 | 19 | 19 | 18 | 17 | 17 | 16 | 16 | 15 | 15 | 14 | 13 | 12 | 11 | 11 | 10 | 9 | 8 | 7 | 5 | 4 | 3 | 1 | 0 |
| 42 | 22 | 21 | 20 | 20 | 19 | 18 | 18 | 17 | 17 | 16 | 15 | 15 | 14 | 13 | 12 | 11 | 10 | 10 | 9 | 7 | 6 | 4 | 3 | 1 | 0 |
| 43 | 23 | 22 | 21 | 21 | 20 | 19 | 19 | 18 | 17 | 17 | 16 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 6 | 4 | 3 | 1 | 0 |
| 44 | 24 | 23 | 22 | 22 | 21 | 20 | 19 | 19 | 18 | 17 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 11 | 10 | 8 | 6 | 5 | 3 | 1 | 0 |
| 45 | 25 | 24 | 23 | 23 | 22 | 21 | 20 | 20 | 19 | 18 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 8 | 6 | 5 | 3 | 2 | 0 |
| 46 | 26 | 25 | 25 | 24 | 23 | 22 | 21 | 21 | 20 | 19 | 18 | 18 | 17 | 15 | 14 | 13 | 12 | 12 | 11 | 9 | 7 | 5 | 3 | 2 | 0 |
| 47 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 21 | 20 | 19 | 19 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 9 | 7 | 5 | 3 | 2 | 0 |
| 48 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 9 | 7 | 5 | 4 | 2 | 0 |
| 49 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 22 | 21 | 20 | 19 | 18 | 16 | 15 | 14 | 13 | 12 | 10 | 8 | 6 | 4 | 2 | 0 |
| 50 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 23 | 22 | 21 | 20 | 18 | 17 | 16 | 15 | 14 | 13 | 10 | 8 | 6 | 4 | 2 | 0 |
| 51 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 24 | 23 | 22 | 20 | 19 | 18 | 16 | 15 | 14 | 13 | 11 | 8 | 6 | 4 | 2 | 0 |
| 52 | 34 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 24 | 23 | 21 | 20 | 18 | 17 | 16 | 15 | 14 | 11 | 9 | 6 | 4 | 2 | 0 |
| 53 | 35 | 34 | 33 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 25 | 24 | 22 | 21 | 19 | 18 | 17 | 15 | 14 | 11 | 9 | 7 | 4 | 2 | 0 |
| 54 | 36 | 35 | 34 | 33 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 25 | 23 | 21 | 20 | 18 | 17 | 16 | 15 | 12 | 9 | 7 | 4 | 2 | 0 |
| 55 | 38 | 36 | 35 | 34 | 33 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 22 | 21 | 19 | 18 | 16 | 15 | 12 | 10 | 7 | 5 | 2 | 0 |
| 56 | 39 | 38 | 36 | 35 | 34 | 33 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 23 | 21 | 20 | 18 | 17 | 16 | 13 | 10 | 7 | 5 | 2 | 0 |
| 57 | 40 | 39 | 38 | 36 | 35 | 34 | 33 | 31 | 30 | 29 | 28 | 27 | 26 | 24 | 22 | 21 | 19 | 18 | 16 | 13 | 10 | 8 | 5 | 2 | 0 |
| 58 | 42 | 40 | 39 | 38 | 36 | 35 | 34 | 33 | 31 | 30 | 29 | 28 | 26 | 25 | 23 | 21 | 20 | 18 | 17 | 14 | 11 | 8 | 5 | 3 | 0 |
| 59 | 43 | 42 | 40 | 39 | 38 | 36 | 35 | 34 | 33 | 31 | 30 | 29 | 27 | 25 | 24 | 22 | 20 | 19 | 18 | 14 | 11 | 8 | 5 | 3 | 0 |
| 60 | 45 | 43 | 42 | 40 | 39 | 37 | 36 | 35 | 34 | 33 | 31 | 30 | 28 | 26 | 25 | 23 | 21 | 20 | 18 | 15 | 11 | 8 | 6 | 3 | 0 |
| 61 | 46 | 45 | 43 | 42 | 40 | 39 | 37 | 36 | 35 | 34 | 32 | 31 | 29 | 27 | 25 | 24 | 22 | 20 | 19 | 15 | 12 | 9 | 6 | 3 | 0 |
| 62 | 48 | 46 | 45 | 43 | 41 | 40 | 39 | 37 | 36 | 35 | 34 | 32 | 30 | 28 | 26 | 24 | 23 | 21 | 19 | 16 | 12 | 9 | 6 | 3 | 0 |
| ′ | 35° | 36° | 37° | 38° | 39° | 40° | 41° | 42° | 43° | 44° | 45° | 46° | 48° | 50° | 25° | 54° | 56° | °58 | 60° | 65° | 70° | 75° | 80° | 85° | 90° |
| | | | | | | | | | | | | | | | | | | | 120 | 115 | 110 | 105 | 100 | 95 | 90 |

# TABLE V.

## To Correct the Distance for the Effect of the Sun's Parallax.

| ☽'s App. Alt. | ☉'s App. Alt. | APPARENT DISTANCE. | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 20° | 22° | 24° | 26° | 28° | 30° | 32° | 34° | 36° | 38° | 40° | 50° | 60° | 70° | 80° | 90° | 100° | 110° | 120° |
| ° | ° | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 10 | 10 | 0 | 0 | — 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | — 1 | — 1 | — 1 | —2 | —2 | — 2 | — 3 | — 3 |
| | 20 | + 4 | + 3 | + 3 | + 3 | + 3 | + 2 | + 2 | + 2 | + 2 | + 2 | + 2 | 0 | 0 | 1 | 2 | 2 | 2 | 3 | 4 |
| | 30 | 8 | 7 | 6 | 6 | 5 | 5 | 5 | 3 | 4 | 3 | 3 | + 2 | 0 | 0 | 1 | 2 | 3 | 4 | 4 |
| | 40 | . | 10 | 9 | 9 | 8 | 7 | 7 | 6 | 6 | 5 | 5 | 3 | + 1 | 0 | 1 | 2 | 3 | 4 | 5 |
| | 50 | . | . | . | . | . | . | 8 | 8 | 8 | 7 | 6 | 4 | 2 | 0 | 1 | 2 | 3 | 4 | 6 |
| | 60 | . | . | . | . | . | . | . | . | . | . | . | 4 | 2 | + 1 | 1 | 2 | 3 | 5 | |
| | 70 | . | . | . | . | . | . | . | . | . | . | . | . | 3 | 1 | 1 | 2 | 3 | | |
| | 80 | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | 0 | 2 | | | |
| 15 | 10 | — 3 | — 2 | — 3 | — 2 | — 2 | — 2 | — 2 | — 1 | — 2 | — 2 | — 2 | — 2 | — 2 | — 1 | —2 | —2 | — 2 | — 3 | — 4 |
| | 20 | + 1 | 1 | + 1 | + 1 | + 1 | 0 | 0 | + 1 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 5 |
| | 30 | 5 | 5 | 4 | 4 | 3 | + 3 | + 2 | 2 | + 2 | + 1 | + 1 | + 1 | 1 | 0 | 1 | 2 | 3 | 4 | 5 |
| | 40 | 8 | 8 | 7 | 7 | 6 | 5 | 4 | 5 | 4 | 3 | 3 | 2 | 0 | 0 | 1 | 2 | 3 | 4 | 6 |
| | 50 | . | . | . | 9 | 8 | 7 | 6 | 6 | 6 | 5 | 4 | 3 | + 1 | 0 | 1 | 2 | 3 | 4 | 7 |
| | 60 | . | . | . | . | . | . | . | . | 7 | 6 | 5 | 3 | 1 | + 1 | 1 | 2 | 3 | 5 | |
| | 70 | . | . | . | . | . | . | . | . | . | . | . | 4 | 2 | 1 | 1 | 2 | 3 | | |
| | 80 | . | . | . | . | . | . | . | . | . | . | . | . | 2 | 1 | 0 | 2 | | | |
| | 90 | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | 0 | | | | |
| 20 | 10 | — 5 | — 4 | — 4 | — 4 | — 3 | — 3 | — 3 | — 3 | — 3 | — 3 | — 3 | — 3 | — 2 | — 2 | —3 | —3 | — 3 | — 4 | — 4 |
| | 20 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 3 | 3 | 3 | 4 | 5 |
| | 30 | + 3 | + 3 | + 3 | + 2 | + 2 | + 2 | + 1 | 0 | + 1 | 0 | 0 | 0 | 1 | 1 | 2 | 3 | 4 | 5 | 5 |
| | 40 | 6 | 6 | 6 | 5 | 5 | 4 | 3 | + 3 | 3 | + 2 | + 2 | + 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| | 50 | . | 9 | 8 | 7 | 7 | 6 | 5 | 5 | 5 | 4 | 3 | 2 | + 1 | 1 | 2 | 3 | 4 | 5 | |
| | 60 | . | . | . | . | . | . | 6 | 6 | 6 | 5 | 4 | 2 | 2 | 0 | 2 | 3 | 4 | | |
| | 70 | . | . | . | . | . | . | . | . | . | . | . | 3 | 2 | 0 | 2 | 3 | | | |
| | 80 | . | . | . | . | . | . | . | . | . | . | . | . | 2 | 0 | 1 | | | | |
| 25 | 10 | — 7 | — 6 | — 5 | — 5 | — 5 | — 4 | — 4 | — 4 | — 4 | — 4 | — 4 | — 4 | — 3 | — 3 | —4 | —4 | — 4 | — 4 | — 5 |
| | 20 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 4 | 4 | 4 | 5 | 6 |
| | 30 | + 1 | + 1 | + 1 | + 1 | 0 | + 1 | 0 | 1 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 4 | 5 | 5 | 6 |
| | 40 | 4 | 4 | 4 | 4 | + 3 | 3 | + 2 | + 2 | + 2 | + 1 | + 1 | + 1 | 1 | 2 | 3 | 4 | 5 | 7 | 7 |
| | 50 | 7 | 6 | 6 | 6 | 5 | 5 | 4 | 4 | 4 | 3 | 2 | 2 | 0 | 2 | 3 | 4 | 5 | 7 | |
| | 60 | . | . | . | 7 | 6 | 6 | 5 | 5 | 5 | 4 | 3 | 2 | 0 | 1 | 3 | 4 | 5 | | |
| | 70 | . | . | . | . | | . | . | . | 6 | 5 | 4 | 3 | + 1 | 1 | 3 | 4 | | | |
| | 80 | . | . | . | . | . | . | . | . | . | . | . | 3 | 1 | 1 | 2 | | | | |
| | 90 | . | . | . | . | . | . | . | . | . | . | . | . | 1 | 1 | | | | | |
| 30 | 10 | — 9 | — 8 | — 8 | — 7 | — 6 | — 6 | — 6 | — 5 | — 6 | — 5 | — 5 | — 5 | — 4 | — 4 | —4 | —4 | — 4 | — 6 | — 6 |
| | 20 | 5 | 5 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 3 | 4 | 3 | 4 | 4 | 4 | 4 | 6 | 7 |
| | 30 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 5 | 7 | 7 |
| | 40 | + 2 | + 2 | + 2 | + 2 | + 2 | + 1 | 0 | + 1 | 0 | 0 | 0 | 1 | 2 | 3 | 3 | 4 | 5 | 7 | |
| | 50 | 5 | 5 | 4 | 4 | 3 | 3 | + 2 | 3 | + 2 | + 2 | + 1 | 0 | 1 | 3 | 3 | 4 | 5 | | |
| | 60 | . | 7 | 6 | 5 | 4 | 4 | 3 | 4 | 3 | 3 | 2 | 0 | 1 | 2 | 3 | 4 | | | |
| | 70 | . | . | . | . | . | . | 4 | 5 | 4 | 4 | 3 | + 1 | 0 | 2 | 3 | | | | |
| | 80 | . | . | . | . | . | . | . | . | . | . | . | 1 | 0 | 2 | | | | | |
| 35 | 10 | —11 | — 9 | — 9 | — 8 | — 8 | — 7 | — 7 | — 6 | — 7 | — 6 | — 6 | — 6 | — 5 | — 4 | —5 | —5 | — 5 | — 6 | — 7 |
| | 20 | 7 | 6 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 4 | 4 | 5 | 4 | 4 | 5 | 5 | 5 | 6 | 8 |
| | 30 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 4 | 5 | 6 | 7 | 8 |
| | 40 | 0 | + 1 | + 1 | + 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | |
| | 50 | + 3 | 4 | 3 | 3 | + 2 | + 2 | + 1 | + 2 | + 1 | + 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | |
| | 60 | 6 | 6 | 5 | 4 | 3 | 3 | 2 | 3 | 2 | 2 | + 1 | 0 | 2 | 2 | 4 | 5 | | | |
| | 70 | . | . | . | 6 | 4 | 4 | 3 | 4 | 3 | 3 | 2 | 0 | 1 | 2 | 4 | | | | |
| | 80 | . | . | . | . | . | . | . | . | 3 | 3 | 2 | 0 | 1 | 2 | | | | | |
| | 90 | . | . | . | . | . | . | . | . | . | . | . | 0 | 1 | | | | | | |
| 40 | 10 | . | —11 | —11 | —10 | — 9 | — 8 | — 8 | — 7 | — 8 | — 7 | — 7 | — 6 | — 5 | — 5 | —6 | —6 | — 6 | — 7 | — 7 |
| | 20 | — 8 | 8 | 7 | 7 | 6 | 6 | 6 | 5 | 6 | 5 | 5 | 5 | 4 | 5 | 6 | 6 | 6 | 7 | 8 |
| | 30 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 5 | 6 | 7 | 8 | |
| | 40 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 4 | 5 | 6 | 7 | | |
| | 50 | + 2 | + 2 | + 1 | + 1 | + 1 | + 1 | 0 | + 1 | 0 | 0 | 1 | 1 | 1 | 4 | 5 | 6 | | | |
| | 60 | 5 | 4 | 3 | 2 | 2 | 2 | + 1 | 2 | + 1 | + 1 | 0 | 1 | 0 | 3 | 5 | | | | |
| | 70 | . | 5 | 4 | 4 | 3 | 3 | 2 | 3 | 2 | 2 | + 1 | 0 | 0 | 3 | | | | | |
| | 80 | . | . | . | . | . | . | . | 3 | 2 | 2 | 1 | 0 | 0 | | | | | | |

# TABLE V.

## To Correct the Distance for the Effect of the Sun's Parallax.

| ☾'s App. Alt. | ☉'s App. Alt. | APPARENT DISTANCE. | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 20° | 22° | 24° | 26° | 28° | 30° | 32° | 34° | 36° | 38° | 40° | 50° | 60° | 70° | 80° | 90° | 100° | 110° | 120° |
| ° | ° | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 45 | 10 | . | . | . | −11 | −10 | −9 | −9 | −8 | −8 | −8 | −8 | −7 | −6 | −6 | −6 | −6 | −6 | 8 | −8 |
| | 20 | −10 | −9 | −8 | 8 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 6 | 5 | 6 | 6 | 6 | 6 | 8 | 10 |
| | 30 | 6 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 4 | 5 | 5 | 4 | 5 | 5 | 5 | 6 | 7 | 9 | |
| | 40 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 4 | 5 | 5 | 6 | 7 | | |
| | 50 | 0 | +1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 | 2 | 3 | 5 | 5 | 6 | | | |
| | 60 | +3 | 3 | +2 | +1 | +1 | +1 | 0 | +1 | +1 | 0 | 1 | 2 | 3 | 4 | 5 | | | | |
| | 70 | 5 | 4 | 3 | 3 | 2 | 2 | +1 | 2 | 2 | +1 | 0 | 1 | 2 | 4 | | | | | |
| | 80 | . | . | . | 4 | 3 | 3 | 2 | 2 | 2 | 1 | 0 | 1 | 2 | | | | | | |
| | 90 | . | . | . | . | . | . | . | . | 3 | 2 | +1 | 1 | | | | | | | |
| 50 | 10 | . | . | . | . | . | . | −9 | −9 | −9 | −9 | −8 | −8 | −7 | −6 | −7 | −7 | −7 | −8 | −9 |
| | 20 | . | −11 | −10 | 9 | −8 | −8 | 7 | 7 | 7 | 7 | 6 | 7 | 6 | 6 | 7 | 7 | 7 | 8 | |
| | 30 | −8 | 7 | 7 | 6 | 6 | 5 | 5 | 6 | 5 | 6 | 5 | 5 | 6 | 5 | 6 | 7 | 8 | | |
| | 40 | 5 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 4 | 5 | 5 | 6 | 7 | | | |
| | 50 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | | | | |
| | 60 | +1 | +1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 4 | 4 | | | | | |
| | 70 | 3 | 2 | +1 | +2 | +1 | +1 | +1 | +1 | +1 | 0 | 0 | 2 | 3 | | | | | | |
| | 80 | . | 4 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 2 | | | | | | | |
| | 90 | . | . | . | . | . | . | 3 | 2 | 2 | +1 | 0 | | | | | | | | |
| 55 | 10 | . | . | . | . | . | . | . | . | . | −10 | −9 | −8 | −7 | −7 | −7 | −7 | −7 | −9 | −9 |
| | 20 | . | . | . | −10 | −9 | −9 | −9 | −9 | −9 | 9 | 7 | 7 | 6 | 7 | 7 | 7 | 7 | 9 | |
| | 30 | −9 | −8 | −8 | 7 | 7 | 6 | 7 | 8 | 7 | 8 | 6 | 5 | 6 | 6 | 6 | 7 | 8 | | |
| | 40 | 6 | 5 | 5 | 4 | 4 | 4 | 5 | 5 | 5 | 6 | 4 | 4 | 5 | 6 | 6 | 7 | | | |
| | 50 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 6 | 6 | | | | |
| | 60 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 3 | 4 | 5 | | | | | |
| | 70 | +2 | +1 | 0 | +1 | 0 | 0 | 1 | 1 | 1 | 2 | 1 | 2 | 3 | | | | | | |
| | 80 | 3 | 3 | +1 | 2 | +1 | +1 | 0 | 1 | 1 | 1 | 1 | 2 | | | | | | | |
| | 90 | . | . | . | 2 | 1 | 1 | +1 | 0 | 0 | 0 | 0 | | | | | | | | |
| 60 | 10 | . | | . | . | . | . | . | . | . | . | . | −9 | −8 | −7 | −8 | −8 | −8 | −9 | |
| | 20 | . | . | . | . | . | . | −9 | −8 | −9 | −8 | −8 | 8 | 7 | 7 | 8 | 8 | 8 | | |
| | 30 | . | −9 | −9 | −8 | −8 | −7 | 7 | 7 | 7 | 7 | 7 | 6 | 7 | 6 | 7 | 8 | | | |
| | 40 | −7 | 6 | 6 | 5 | 7 | 5 | 5 | 4 | 5 | 5 | 5 | 5 | 6 | 6 | 7 | | | | |
| | 50 | 4 | 3 | 4 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | | | | | |
| | 60 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 3 | 4 | 5 | | | | | | |
| | 70 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 2 | 3 | | | | | | | |
| | 80 | 2 | +2 | 0 | +1 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | | | | | | | | |
| | 90 | . | 2 | +1 | 1 | 0 | 0 | +1 | +1 | 0 | 0 | | | | | | | | | |
| 70 | 10 | . | . | . | . | . | . | . | . | . | . | . | . | −9 | −8 | −9 | −8 | −9 | | |
| | 20 | . | . | . | . | . | . | . | . | . | . | . | −9 | 8 | 8 | 9 | 8 | | | |
| | 30 | . | . | . | . | . | . | −9 | −9 | −9 | −9 | −8 | 7 | 8 | 7 | 8 | | | | |
| | 40 | . | −8 | −7 | −7 | −6 | −7 | 7 | 7 | 7 | 7 | 6 | 6 | 7 | 7 | | | | | |
| | 50 | −6 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | | | | | | |
| | 60 | 3 | 3 | 3 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | | | | | | | |
| | 70 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | | | | |
| | 80 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | | | | | | | | | |
| 80 | 10 | . | . | . | . | . | . | . | . | . | . | . | . | −8 | −9 | −9 | | | | |
| | 20 | . | . | . | . | . | . | . | . | . | . | . | −8 | 8 | 9 | | | | | |
| | 30 | . | . | . | . | . | . | . | . | . | . | −7 | 8 | 7 | | | | | | |
| | 40 | . | . | . | . | . | . | −8 | −7 | −7 | −6 | 6 | 7 | | | | | | | |
| | 50 | . | −6 | −7 | −6 | −5 | −5 | 6 | 5 | 5 | 5 | 5 | | | | | | | | |
| | 60 | −4 | 4 | 5 | 5 | 4 | 4 | 5 | 4 | 4 | 4 | | | | | | | | | |
| | 70 | 2 | 3 | 4 | 3 | 3 | 3 | 4 | 3 | 3 | | | | | | | | | | |
| | 80 | 1 | 1 | 3 | 2 | 2 | | | | | | | | | | | | | | |
| 90 | 10 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | −9 | | | | |
| | 20 | . | . | . | . | . | . | . | . | . | . | . | . | . | −8 | | | | | |
| | 30 | . | . | . | . | . | . | . | . | . | . | . | . | −8 | | | | | | |
| | 40 | . | . | . | . | . | . | . | . | . | . | . | −6 | | | | | | | |
| | 50 | . | . | . | . | . | . | −7 | −6 | −6 | −6 | −6 | | | | | | | | |
| | 60 | . | −4 | −5 | −5 | −5 | −5 | 6 | 5 | 5 | 5 | | | | | | | | | |
| | 70 | −3 | 3 | 4 | 3 | 4 | | | | | | | | | | | | | | |

# TABLE VI.

## TO FIND THE LATITUDE BY AN ALTITUDE OF THE NORTH POLAR STAR.

| R. A. of M | *s cor Alt. | R. A. of M | *s cor Alt. | R. A. of M | *s cor Alt. | R. A. of M | *s cor Alt. | R. A. of M | *s cor Alt. | R. A. of M | *s cor Alt. | R. A. of M | *s cor Alt. | R. A. of M | *s cor Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h.m. | ° ′ | h.m. | ° ′ | h.m. | ° ′ | h.m. | ° ′ | h.m. | ° ′ | h. m. | ° ′ | h.m. | ° ′ | h.m. | ° ′ |
| 0. 0 | —1.34 | 4.20 | —1. 2 | 6.50 | —0. 4 | 9.18 | +0.55 | 12.59 | +1.37 | 16.40 | +0.55 | 19. 8 | —0. 4 | 21.38 | —1. 2 |
| 0. 8 | —1.35 | 4.25 | —1. 0 | 6.55 | —0. 1 | 9.23 | +0.57 | 13.20 | +1.37 | 16.45 | +0.54 | 19.13 | —0. 6 | 21.43 | —1. 3 |
| 0.18 | —1.36 | 4.30 | —0.59 | 6.59 | —0. 0 | 9.28 | +0.59 | 13.40 | +1.36 | 16.50 | +0.52 | 19.18 | —0. 8 | 21.48 | —1. 5 |
| 0.38 | —1.37 | 4.35 | —0.57 | 7. 3 | +0. 1 | 9.33 | +1. 0 | 13.50 | +1.35 | 16.55 | +0.50 | 19.23 | —0.10 | 21.53 | —1. 7 |
| 0.59 | —1.37 | 4.40 | —0.55 | 7. 8 | +0. 4 | 9.38 | +1. 2 | 14. 0 | +1.34 | 17. 0 | +0.48 | 19.28 | —0.12 | 21.58 | —1. 8 |
| 1.20 | —1.37 | 4.45 | —0.54 | 7.13 | +0. 6 | 9.43 | +1. 3 | 14.10 | +1.32 | 17. 5 | +0.46 | 19.33 | —0.14 | 22. 3 | —1.10 |
| 1.40 | —1.36 | 4.50 | —0.52 | 7.18 | +0. 8 | 9.48 | +1. 5 | 14.20 | +1.31 | 17.10 | +0.44 | 19.38 | —0·16 | 22. 8 | —1.11 |
| 1.50 | —1.35 | 4.55 | —0.50 | 7.23 | +0.10 | 9.53 | +1. 7 | 14.30 | +1.29 | 17.15 | +0.42 | 19.43 | —0.18 | 22.13 | —1.13 |
| 2. 0 | —1.34 | 5. 0 | —0.48 | 7.28 | +0.12 | 9.58 | +1. 8 | 14.40 | +1.28 | 17.20 | +0.40 | 19.48 | —0.20 | 22.18 | —1.14 |
| 2.10 | —1.32 | 5. 5 | —0.46 | 7.33 | +0.14 | 10. 3 | +1.10 | 14.50 | +1.26 | 17.25 | +0.38 | 19.53 | —0.22 | 22.23 | —1.15 |
| 2.20 | —1.31 | 5.10 | —0.44 | 7.38 | +0.16 | 10. 8 | +1.11 | 15. 0 | +1.24 | 17.30 | +0.37 | 19.58 | —0.25 | 22.28 | —1.17 |
| 2.30 | —1.29 | 5.15 | —0.42 | 7.43 | +0.18 | 10.13 | +1.13 | 15. 5 | +1.23 | 17.35 | +0.35 | 20. 3 | —0.27 | 22.33 | —1.18 |
| 2.40 | —1.28 | 5.20 | —0.40 | 7.48 | +0.20 | 10.18 | +1.14 | 15.10 | +1.22 | 17.40 | +0.33 | 20. 8 | —0.30 | 22.38 | —1.19 |
| 2.50 | —1.26 | 5.25 | —0.38 | 7.53 | +0.22 | 10.23 | +1.15 | 15.15 | +1.20 | 17.45 | +0.32 | 20.13 | —0.32 | 22.43 | —1.20 |
| 3. 0 | —1.24 | 5.30 | —0.37 | 7.58 | +0.25 | 10.28 | +1.17 | 15.20 | +1.19 | 17.50 | +0.30 | 20.18 | —0.33 | 22.48 | —1.22 |
| 3. 5 | —1.23 | 5.35 | —0.35 | 8. 3 | +0.27 | 10.33 | +1.18 | 15.25 | +1.18 | 17.55 | +0.27 | 20.23 | —0.35 | 22.53 | —1.23 |
| 3.10 | —1.22 | 5.40 | —0.33 | 8. 8 | +0.30 | 10.38 | +1.19 | 15.30 | +1.17 | 18. 0 | +0.25 | 20.28 | —0.37 | 22.58 | —1.24 |
| 3.15 | —1.20 | 5.45 | —0.32 | 8.13 | +0.32 | 10.43 | +1.20 | 15.35 | +1.15 | 18. 5 | +0.22 | 20.33 | —0.38 | 23. 8 | —1.26 |
| 3.20 | —1.19 | 5.50 | —0.30 | 8.18 | +0.33 | 10.48 | +1.22 | 15.40 | +1.14 | 18.10 | +0.20 | 20.38 | —0.40 | 23.18 | —1.28 |
| 3.25 | —1.18 | 5.55 | —0.27 | 8.23 | +0.35 | 10.53 | +1.23 | 15.45 | +1.13 | 18.15 | +0.18 | 20.43 | —0.42 | 23.28 | —1.29 |
| 3.30 | —1.17 | 6. 0 | —0.25 | 8.28 | +0.37 | 10.58 | +1.24 | 15.50 | +1.11 | 18.20 | +0.16 | 20.48 | —0·44 | 23.38 | —1.31 |
| 3.35 | —1.15 | 6. 5 | —0.22 | 8.33 | +0.38 | 11. 8 | +1.26 | 15.55 | +1.10 | 18.25 | +0.14 | 20.53 | —0.46 | 23.48 | —1.32 |
| 3.40 | —1.14 | 6.10 | —0.20 | 8.38 | +0.40 | 11.18 | +1.28 | 16. 0 | +1. 8 | 18.30 | +0.12 | 20.58 | —0.48 | 23.58 | —1.34 |
| 3.45 | —1.13 | 6.15 | —0.18 | 8.43 | +0.42 | 11.28 | +1.29 | 16. 5 | +1. 7 | 18.35 | +0.10 | 21. 3 | —0.50 | | |
| 3.50 | —1.11 | 6.20 | —0.16 | 8.48 | +0.44 | 11.38 | +1.31 | 16.10 | +1. 5 | 18.40 | +0. 8 | 21. 8 | —0.52 | | |
| 3.55 | —1.10 | 6.25 | —0.14 | 8.53 | +0.46 | 11.48 | +1.32 | 16.15 | +1. 3 | 18.45 | +0. 6 | 21.13 | —0.54 | | |
| 4. 0 | —1. 8 | 6.30 | —0.12 | 8.58 | +0.48 | 11.58 | +1.34 | 16.20 | +1. 2 | 18.50 | +0. 4 | 21.18 | —0.55 | | |
| 4. 5 | —1. 7 | 6.35 | —0.10 | 9. 3 | +0.50 | 12. 8 | +1.35 | 16.25 | +1. 0 | 18.55 | +0. 1 | 21.23 | —0.57 | | |
| 4.10 | —1. 5 | 6.40 | —0. 8 | 9. 8 | +0.52 | 12.18 | +1.36 | 16.30 | +0.59 | 19. 0 | 0. 0 | 21.28 | —0.59 | | |
| 4.15 | —1. 3 | 6.45 | —0. 6 | 9.13 | +0.54 | 12.38 | +1.37 | 16.35 | +0.57 | 19. 3 | —0. 1 | 21.33 | —1. 0 | | |

# TABLE VII.

## RIGHT ASCENCIONS AND DECLINATIONS OF 24 OF THE PRINCIPAL FIXED STARS, JAN. 1, 1826.

| No. of Star. | Names of the Stars. | Right Ascen. in time. | Annual Var. | Declination. | Annual Var. | Bearing & dist. of celest. objects when * is on Merid. |
|---|---|---|---|---|---|---|
| | | h. m. s. | ″ | ° ′ ″ | ″ | ° ′ |
| 1 | Mirach. - - - - | 1 0 0 | +3, 3 | 34.41.48 N | +19, 4 | Pleiades, E. by S.-----36.20 |
| 2 | Achernar. - - - | 1 31 13 | 2, 2 | 58. 7.20 S | —18, 5 | Fomalhaut, N. W.----39. 0 |
| 3 | Arietis.* - - - - | 1 57 23 | 3, 3 | 22.38. 9 N | +17, 4 | Pleiades, E. ½ N.------23. 0 |
| 4 | Aldebaran.* - - - | 4 25 57 | 3, 4 | 16. 9.10 N | + 8, 0 | Pleiades, N. W.-------13.40 |
| 5 | Capella. - - - - | 5 3 51 | 4, 4 | 45.48.39 N | + 4, 6 | Pleiades, S. W.--------28.20 |
| 6 | Rigel. - - - - | 5 6 11 | 2, 9 | 8.24.30 S | — 4, 9 | Aldebaran, N. N. W.--26.40 |
| 7 | Betelguese. - - - | 5 45 46 | 3, 2 | 7.22. 2 N | + 1, 4 | Sirius, S. S. E.---------27.20 |
| 8 | Canopus. - - - | 6 20 6 | 1, 3 | 52.36.13 S | + 1, 7 | Sirius, N. ¼ E.---------36. 0 |
| 9 | Sirius. - - - - - | 6 37 29 | 2, 6 | 16.28.57 S | + 4, 4 | Orion's belt, N. W.---21.40 |
| 10 | Castor. - - - - | 7 23 30 | 3, 9 | 32.15.42 N | — 7, 1 | Pollux, S. S. E.------- 4.30 |
| 11 | Pollux.* - - - - | 7 34 39 | 3, 7 | 28.26.20 N | — 8, 0 | Aldebaran, W. S. W. 45. 0 |
| 12 | Alphard. - - - | 9 18 59 | 3, 0 | 7.54.29 S | +15, 2 | Regulus, N. N. E.----23.20 |
| 13 | Regulus.* - - - - | 9 59 6 | 3, 2 | 12.48.52 N | —17, 3 | Pollux, N. N. W.------37. 0 |
| 14 | Dubhe. - - - - | 10 52 51 | 3, 8 | 62.41.18 N | —19, 3 | Pole Star, N.-----------28.45 |
| 15 | Denebola. - - - - | 11 40 8 | 3. 1 | 15.32.42 N | —20, 0 | Regulus, W. ¼ S.-----24.40 |
| 16 | Spica.* - - - - | 13 15 59 | 3, 1 | 10.14.57 S | +19, 0 | Antares, E. by S. ½ S. 46. 0 |
| 17 | Arcturus. - - - - | 14 7 44 | 2, 7 | 20. 5.34 N | —19, 0 | Alphaca, E. N. E.---19.20 |
| 18 | Antares.* - - - | 16 18 40 | 3, 7 | 26. 2. 8 S | + 8, 6 | *a* Pegasi, N. E.---------60. 0 |
| 19 | Lyra. - - - - - | 18 31 3 | 2, 0 | 38.37.39 N | + 3, 0 | *a* Aquila, S. E. by S. 34.20 |
| 20 | Aquila.* - - - - | 19 42 18 | 2, 9 | 8.24.59 N | + 9, 1 | *a* Pegasi, E. ½ N.------48. 0 |
| 21 | Deneb. - - - - | 20 35 30 | 2, 0 | 44.39.47 N | +12, 6 | *a* Lyra, W. S. W.-----24. 0 |
| 22 | Fomalhaut.* - - | 22 48 1 | 3, 3 | 30.32.32 S | —19, 1 | *a* Pegasi, N. ¼ E.------45. 0 |
| 23 | Pegasi.* - - - - | 22 56 6 | 3, 0 | 14.16.21 N | +19, 4 | *a* Arietis, E. by N.----44. 0 |
| 24 | Alpheratz. - - - | 23 59 25 | 3, 1 | 28. 7.50 N | +20, 0 | *a* Pegasi, S. W.--------20.20 |

* Stars thus marked, are those which are used in the Lunar Observations.

# TABLE VIII.

## TRANSITS OF 24 OF THE PRINCIPAL FIXED STARS, OVER THE MERIDIAN OF GREENWICH, IN APPARENT TIME.

### JANUARY.

| No. of *. | DAY. 5 | DAY. 10. | DAY. 15. | DAY. 20. | DAY. 25. | DAY. 30. |
|---|---|---|---|---|---|---|
| | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. |
| 1 | 5.55 | 5.33 | 5.12 | 4.50 | 4.30 | 4. 9 |
| 2 | 6.36 | 6. 5 | 5.43 | 5.22 | 5. 1 | 4.40 |
| 3 | 6.52 | 6.31 | 6. 9 | 5.48 | 5.27 | 5. 6 |
| 4 | 9.20 | 8.59 | 8.37 | 8.16 | 7.55 | 7.34 |
| 5 | 9.58 | 9.36 | 9.15 | 8.54 | 8.33 | 8.12 |
| 6 | 10. 1 | 9.39 | 9.17 | 8.56 | 8.35 | 8.14 |
| 7 | 10.40 | 10.18 | 9.57 | 9.35 | 9.14 | 8.54 |
| 8 | 11.14 | 10.53 | 10.31 | 10.10 | 9.49 | 9.28 |
| 9 | 11.32 | 11.10 | 10.48 | 10.27 | 10. 6 | 9.45 |
| 10 | 12.17 | 11.56 | 11.34 | 11.13 | 10.52 | 10.31 |
| 11 | 12.29 | 12. 7 | 11.45 | 11.24 | 11. 3 | 10.42 |
| 12 | 14.13 | 13.51 | 13.29 | 13. 8 | 12.47 | 12.26 |
| 13 | 14.53 | 14.31 | 14. 9 | 13.48 | 13.27 | 13. 6 |
| 14 | 15.46 | 15.24 | 15. 3 | 14.42 | 14.21 | 14. 0 |
| 15 | 16.33 | 16.12 | 15.50 | 15.29 | 15. 8 | 14.47 |
| 16 | 18. 9 | 17.47 | 17.26 | 17. 4 | 16.43 | 16.23 |
| 17 | 19. 1 | 18.39 | 18.17 | 17.56 | 17.35 | 17.14 |
| 18 | 21.11 | 20.49 | 20.28 | 20. 6 | 19.46 | 19.25 |
| 19 | 23.23 | 23. 1 | 22.40 | 22.18 | 21.58 | 21.37 |
| 20 | 0.38 | 0.17 | 23.51 | 23.29 | 23. 9 | 22.48 |
| 21 | 1.32 | 1.10 | 0.48 | 0.27 | 0. 6 | 23.41 |
| 22 | 3.44 | 3.22 | 3. 0 | 2.39 | 2.18 | 1.57 |
| 23 | 3.52 | 3.30 | 3. 8 | 2.47 | 2.26 | 2. 5 |
| 24 | 4.55 | 4.33 | 4.11 | 3.50 | 3.29 | 3. 8 |

For every intervening day allow 4¼ minutes.

### FEBRUARY.

| No. of *. | DAY. 5 | DAY. 10. | DAY. 15. | DAY. 20. | DAY. 25. | DAY. 28. |
|---|---|---|---|---|---|---|
| | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. |
| 1 | 3.45 | 3.25 | 3. 5 | 2.46 | 2.27 | 2.16 |
| 2 | 4.16 | 3.56 | 3.36 | 3.17 | 2.58 | 2.47 |
| 3 | 4.42 | 4.22 | 4. 2 | 3.43 | 3.24 | 3.13 |
| 4 | 7.10 | 6.50 | 6.31 | 6.11 | 5.52 | 5.41 |
| 5 | 7.48 | 7.28 | 7. 8 | 6.49 | 6.30 | 6.19 |
| 6 | 7.50 | 7.30 | 7.11 | 6.51 | 6.32 | 6.21 |
| 7 | 8.30 | 8.10 | 7.50 | 7.31 | 7.12 | 7.01 |
| 8 | 9. 4 | 8.44 | 8.24 | 8. 5 | 7.46 | 7.35 |
| 9 | 9.21 | 9. 1 | 8.42 | 8.22 | 8. 3 | 7.52 |
| 10 | 10. 7 | 9.47 | 9.27 | 9. 8 | 8.49 | 8.38 |
| 11 | 10.18 | 9.58 | 9.39 | 9.19 | 9. 0 | 8.49 |
| 12 | 12. 2 | 11.42 | 11.23 | 11. 4 | 10.45 | 10.33 |
| 13 | 12.42 | 12.22 | 12. 3 | 11.44 | 11.25 | 11.13 |
| 14 | 13.36 | 13.16 | 12.56 | 12.37 | 12.18 | 12. 7 |
| 15 | 14.23 | 14. 3 | 13.44 | 13.24 | 13. 5 | 12.54 |
| 16 | 15.59 | 15.39 | 15.19 | 15. 0 | 14.41 | 14.30 |
| 17 | 16.50 | 16.30 | 16.11 | 15.52 | 15.33 | 15.21 |
| 18 | 19. 1 | 18.41 | 18.21 | 18. 2 | 17.43 | 17.32 |
| 19 | 21.13 | 20.53 | 20.33 | 20.14 | 19.55 | 19.44 |
| 20 | 22.24 | 22. 4 | 21.44 | 21.25 | 21. 6 | 20.55 |
| 21 | 23.17 | 22.57 | 22.37 | 22.18 | 21.59 | 21.48 |
| 22 | 1.33 | 1.13 | 0.53 | 0.34 | 0.15 | 0. 4 |
| 23 | 1.41 | 1.21 | 1. 2 | 0.43 | 0.23 | 0.12 |
| 24 | 2.44 | 2.24 | 2. 5 | 1.45 | 1.26 | 1.15 |

For every intervening day allow 4 minutes.

### MARCH.

| No. of *. | DAY. 5. | DAY. 10. | DAY. 15. | DAY. 20. | DAY. 25. | DAY. 30. |
|---|---|---|---|---|---|---|
| | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. |
| 1 | 1.57 | 1.39 | 1.20 | 1. 2 | 0.44 | 0.26 |
| 2 | 2.28 | 2.10 | 1.51 | 1.33 | 1.15 | 0.57 |
| 3 | 2.54 | 2.36 | 2.17 | 1.59 | 1.41 | 1.23 |
| 4 | 5.22 | 5.04 | 4.46 | 4.27 | 4. 9 | 3.51 |
| 5 | 6. 0 | 5.42 | 5.23 | 5. 5 | 4.47 | 4.29 |
| 6 | 6. 3 | 5.44 | 5.26 | 5. 8 | 4.50 | 4.31 |
| 7 | 6.42 | 6.24 | 6.06 | 5.47 | 5.29 | 5.11 |
| 8 | 7.16 | 6.58 | 6.40 | 6.21 | 6. 3 | 5.45 |
| 9 | 7.34 | 7.15 | 6.57 | 6.39 | 6.21 | 6. 2 |
| 10 | 8.19 | 8. 1 | 7.43 | 7.25 | 7. 6 | 6.48 |
| 11 | 8.31 | 8.12 | 7.54 | 7.36 | 7.18 | 6.59 |
| 12 | 10.15 | 9.56 | 9.38 | 9.20 | 9. 2 | 8.44 |
| 13 | 10.55 | 10.36 | 10.18 | 10. 0 | 9.42 | 9.24 |
| 14 | 11.48 | 11.30 | 11.12 | 10.53 | 10.35 | 10.17 |
| 15 | 12.36 | 12.17 | 11.59 | 11.41 | 11.23 | 11. 4 |
| 16 | 14.11 | 13.53 | 13.34 | 13.16 | 12.58 | 12.40 |
| 17 | 15. 3 | 14.44 | 14.26 | 14. 8 | 13.50 | 13.32 |
| 18 | 17.13 | 16.55 | 16.37 | 16.18 | 16. 0 | 15.42 |
| 19 | 19.25 | 19. 7 | 18.49 | 18.31 | 18.12 | 17.54 |
| 20 | 20.36 | 20.18 | 20. 0 | 19.42 | 19.23 | 19. 5 |
| 21 | 21.30 | 21.11 | 20.53 | 20.35 | 20.17 | 19.58 |
| 22 | 23.42 | 23.23 | 23. 5 | 22.47 | 22.29 | 22.11 |
| 23 | 23.50 | 23.31 | 23.13 | 22.55 | 22.37 | 22.19 |
| 24 | 00.57 | 0.38 | 0.20 | 0. 2 | 23.40 | 23.22 |

For every intervening day allow 3¾ minutes.

### APRIL.

| No. of *. | DAY. 5. | DAY. 10. | DAY. 15. | DAY. 20. | DAY. 25. | DAY. 30. |
|---|---|---|---|---|---|---|
| | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. |
| 1 | 0. 4 | 23.42 | 23.24 | 23. 5 | 22.47 | 22.28 |
| 2 | 0.35 | 0.17 | 23.55 | 23.36 | 23.18 | 22.59 |
| 3 | 1, 1 | 0.43 | 0.25 | 0. 6 | 23.44 | 23.25 |
| 4 | 3.29 | 3.11 | 2.53 | 2.34 | 2.16 | 1.57 |
| 5 | 4. 7 | 3.49 | 3.31 | 3.12 | 2.54 | 2.35 |
| 6 | 4.10 | 3.51 | 3.33 | 3.15 | 2.56 | 2.37 |
| 7 | 4.49 | 4.31 | 4.13 | 3.54 | 3.35 | 3.17 |
| 8 | 5.23 | 5. 5 | 4.47 | 4.28 | 4.10 | 3.51 |
| 9 | 5.41 | 5.23 | 5. 4 | 4.46 | 4.27 | 4. 8 |
| 10 | 6.27 | 6. 8 | 5.50 | 5.31 | 5.13 | 4.54 |
| 11 | 6.38 | 6.19 | 6. 1 | 5.43 | 5.24 | 5. 5 |
| 12 | 8.22 | 8. 4 | 7.45 | " 27 | 7. 8 | 6.49 |
| 13 | 9. 2 | 8.44 | 8.25 | 8. 7 | 7.48 | 7.29 |
| 14 | 9.56 | 9.37 | 9.19 | 9. 0 | 8.42 | 8.23 |
| 15 | 10.43 | 10.24 | 10. 6 | 9.48 | 9.29 | 9.10 |
| 16 | 12.18 | 12. 1 | 11.42 | 11.23 | 11. 5 | 10.46 |
| 17 | 13.10 | 12.52 | 12.33 | 12.15 | 11.56 | 11.37 |
| 18 | 15.21 | 15. 2 | 14 44 | 14.25 | 14. 7 | 13.48 |
| 19 | 17.33 | 17.14 | 16.56 | 26.37 | 16.19 | 16. 1 |
| 20 | 18.44 | 18.25 | 18. 7 | 17.48 | 17.30 | 17.11 |
| 21 | 19.37 | 19.18 | 19. 1 | 18.42 | 18.23 | 18. 4 |
| 22 | 21.49 | 21.30 | 21.12 | 20.54 | 20.35 | 20.16 |
| 23 | 21.57 | 21.39 | 21.20 | 21. 2 | 20.43 | 20.24 |
| 24 | 23. 0 | 22.42 | 22.23 | 22. 5 | 21.46 | 21.27 |

For every intervening day allow 3¾ minutes.

# TABLE VIII.

## TRANSITS OF 24 OF THE PRINCIPAL FIXED STARS, OVER THE MERIDIAN OF GREENWICH, IN APPARENT TIME.

| No. of * | MAY. | | | | | |
|---|---|---|---|---|---|---|
| | DAY. 5 | DAY. 10. | DAY. 15. | DAY. 20. | DAY. 25. | DAY. 30. |
| | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. |
| 1 | 22. 9 | 21.49 | 21.30 | 21.10 | 20.50 | 20.30 |
| 2 | 22.40 | 22.21 | 22. 1 | 21.41 | 21.21 | 21. 1 |
| 3 | 23. 6 | 22.47 | 22.27 | 22. 7 | 21.47 | 21.27 |
| 4 | 1.38 | 1.19 | 0.59 | 0.39 | 0.19 | 0. 0 |
| 5 | 2.16 | 1.56 | 1.37 | 1.17 | 0.57 | 0.37 |
| 6 | 2.18 | 1.59 | 1.39 | 1.19 | 0.59 | 0.39 |
| 7 | 2.57 | 2.38 | 2.19 | 1.59 | 1.39 | 1.19 |
| 8 | 3.32 | 3.13 | 2.53 | 2.33 | 2.13 | 1.53 |
| 9 | 3.49 | 3.30 | 3.10 | 2.50 | 2.30 | 2.10 |
| 10 | 4.35 | 4.16 | 3.56 | 3.36 | 3.16 | 2.56 |
| 11 | 4.46 | 4.27 | 4. 7 | 3.47 | 3.27 | 3. 7 |
| 12 | 6.30 | 6.11 | 5.51 | 5.32 | 5.12 | 4.51 |
| 13 | 7.10 | 6.51 | 6.31 | 6.12 | 5.52 | 5.31 |
| 14 | 8. 4 | 7.45 | 7.25 | 7. 5 | 6.45 | 6.25 |
| 15 | 8.51 | 8.32 | 8.12 | 7.52 | 7.32 | 7.12 |
| 16 | 10.27 | 10. 7 | 9.48 | 9.28 | 9. 8 | 8.48 |
| 17 | 11.18 | 10.59 | 10.39 | 10.19 | 9.59 | 9.39 |
| 18 | 13.29 | 13. 9 | 12.50 | 12.30 | 12.10 | 11.50 |
| 19 | 15.41 | 15.21 | 15. 2 | 14.42 | 14.22 | 14. 2 |
| 20 | 16.52 | 16.32 | 16.13 | 15.53 | 15.33 | 15.13 |
| 21 | 17.45 | 17.26 | 17. 6 | 16.46 | 16.26 | 16. 6 |
| 22 | 19.57 | 19.38 | 19.18 | 18.58 | 18.38 | 18.18 |
| 23 | 20. 5 | 19.46 | 19.26 | 19. 6 | 18.46 | 18.26 |
| 24 | 21. 8 | 20.49 | 20.29 | 20.10 | 19.49 | 19.29 |

For every intervening day allow 4 minutes.

| No. of * | JUNE. | | | | | |
|---|---|---|---|---|---|---|
| | DAY. 5 | DAY. 10. | DAY. 15. | DAY. 20. | DAY. 25. | DAY. 30. |
| | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. |
| 1 | 20. 5 | 19.44 | 19.24 | 19. 3 | 18.42 | 18.22 |
| 2 | 20.36 | 20.16 | 19.55 | 19.34 | 19.14 | 18.53 |
| 3 | 21. 2 | 20.42 | 20.21 | 20. 0 | 19.40 | 19.19 |
| 4 | 23.30 | 23.10 | 22.49 | 22.28 | 22. 8 | 21.47 |
| 5 | 0.12 | 23.48 | 23.27 | 23. 6 | 22.45 | 22.25 |
| 6 | 0.15 | 23.50 | 23.29 | 23. 9 | 22.48 | 22.27 |
| 7 | 0.54 | 0.34 | 0.13 | 23.48 | 23.27 | 23. 7 |
| 8 | 1.28 | 1. 8 | 0.47 | 0.27 | 0. 6 | 23.41 |
| 9 | 1.46 | 1.25 | 1. 4 | 0.44 | 0.23 | 0. 2 |
| 10 | 2.32 | 2.11 | 1.50 | 1.30 | 1. 9 | 0.48 |
| 11 | 2.43 | 2.22 | 2. 1 | 1.41 | 1.20 | 0.59 |
| 12 | 4.27 | 4. 6 | 3.46 | 3.25 | 3. 4 | 2.43 |
| 13 | 5. 7 | 4.46 | 4.25 | 4. 5 | 3.44 | 3.23 |
| 14 | 6. 0 | 5.40 | 5.19 | 4.58 | 4.38 | 4.17 |
| 15 | 6.48 | 6.27 | 6. 6 | 5.46 | 5.25 | 5. 4 |
| 16 | 8.23 | 8. 3 | 7.42 | 7.21 | 7. 0 | 6.40 |
| 17 | 9.15 | 8.54 | 8.33 | 8.13 | 7.52 | 7.31 |
| 18 | 11.25 | 11. 5 | 10.44 | 10.23 | 10. 3 | 9.42 |
| 19 | 13.37 | 13.17 | 12.56 | 12.35 | 12.15 | 11.54 |
| 20 | 14.48 | 14.28 | 14. 7 | 13.46 | 13.26 | 13. 5 |
| 21 | 15.41 | 15.21 | 15. 0 | 14.39 | 14.19 | 13.58 |
| 22 | 17.53 | 17.33 | 17.12 | 16.51 | 16.31 | 16.10 |
| 23 | 18. 2 | 17.41 | 17.20 | 17. 0 | 16.39 | 16.18 |
| 24 | 19. 5 | 18.44 | 18.23 | 18. 3 | 17.42 | 17.21 |

For every intervening day allow 4 minutes.

| No. of * | JULY | | | | | |
|---|---|---|---|---|---|---|
| | DAY. 5. | DAY. 10. | DAY. 15. | DAY. 20. | DAY. 25. | DAY. 30. |
| | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. |
| 1 | 18. 1 | 17.41 | 17.20 | 17. 0 | 16.40 | 16.21 |
| 2 | 18.32 | 18.12 | 17.52 | 17.31 | 17.12 | 16.52 |
| 3 | 18.58 | 18.38 | 18.18 | 17.58 | 17.38 | 17.18 |
| 4 | 21.26 | 21. 6 | 20.46 | 20.26 | 20. 6 | 19.46 |
| 5 | 22. 4 | 21.44 | 21.24 | 21. 3 | 20.44 | 20.24 |
| 6 | 22. 7 | 21.46 | 21.26 | 21. 6 | 20.46 | 20.26 |
| 7 | 22.46 | 22.26 | 22. 5 | 21.45 | 21.25 | 21. 6 |
| 8 | 23.20 | 23. 0 | 22.40 | 22.20 | 22. 0 | 21.40 |
| 9 | 23.38 | 23.17 | 22.57 | 22.37 | 22.17 | 21.57 |
| 10 | 0.28 | 0. 7 | 23.43 | 23.23 | 23. 3 | 22.43 |
| 11 | 0.39 | 0.18 | 23.54 | 23.34 | 23.14 | 22.54 |
| 12 | 2.23 | 2. 2 | 1.42 | 1.22 | 1. 2 | 0.42 |
| 13 | 3. 3 | 2.42 | 2.22 | 2. 2 | 1.42 | 1.22 |
| 14 | 3.56 | 3.36 | 3.16 | 2.56 | 2.36 | 2.16 |
| 15 | 4.44 | 4.23 | 4. 3 | 3.43 | 3.23 | 3. 3 |
| 16 | 6.19 | 5.59 | 5.38 | 5.18 | 4.58 | 4.39 |
| 17 | 7.11 | 6.50 | 6.30 | 6.10 | 5.50 | 5.30 |
| 18 | 9.21 | 9. 1 | 8.41 | 8.20 | 8. 1 | 7.41 |
| 19 | 11.33 | 11.13 | 10.53 | 10.32 | 10.13 | 9.53 |
| 20 | 11.44 | 12.24 | 12. 4 | 11.43 | 11.24 | 11. 4 |
| 21 | 13.37 | 13.17 | 12.57 | 12.37 | 12.17 | 11.57 |
| 22 | 15.49 | 15.29 | 15. 9 | 14.49 | 14.29 | 14. 9 |
| 23 | 15.58 | 15.37 | 15.17 | 14.57 | 14.37 | 14.17 |
| 24 | 17. 1 | 16.40 | 16.20 | 16. 0 | 15.40 | 15.20 |

For every intervening day allow 4 minutes.

| No. of * | AUGUST. | | | | | |
|---|---|---|---|---|---|---|
| | DAY. 5. | DAY. 10. | DAY. 15. | DAY. 20. | DAY. 25. | DAY. 30. |
| | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. |
| 1 | 15.58 | 15.39 | 15.20 | 15. 1 | 14.43 | 14.25 |
| 2 | 16.29 | 16.10 | 15.51 | 15.32 | 15.14 | 14.56 |
| 3 | 16.55 | 16.36 | 16.17 | 15.58 | 15.40 | 15.22 |
| 4 | 19.23 | 19. 4 | 18.45 | 18.27 | 18. 8 | 17.50 |
| 5 | 20. 1 | 19.42 | 19.23 | 19. 4 | 18.46 | 18.28 |
| 6 | 20. 3 | 19.44 | 19.25 | 19. 7 | 18.48 | 18.30 |
| 7 | 20.43 | 20.24 | 20. 5 | 19.46 | 19.28 | 19.10 |
| 8 | 21.17 | 20.58 | 20.39 | 20.21 | 20· 2 | 19.44 |
| 9 | 21.34 | 21.15 | 20.56 | 20.38 | 20.19 | 20. 1 |
| 10 | 22.20 | 22. 1 | 21.42 | 21.24 | 21. 5 | 20.47 |
| 11 | 22.31 | 22.12 | 21.53 | 21.35 | 21.16 | 20.58 |
| 12 | 0.19 | 0. 0 | 23.38 | 23.19 | 23. 1 | 22.42 |
| 13 | 0.59 | 0.40 | 0.21 | 0. 3 | 23.41 | 23.22 |
| 14 | 1.53 | 1.34 | 1.15 | 0.56 | 0.38 | 0.20 |
| 15 | 2.40 | 2.21 | 2. 2 | 1.43 | 1.25 | 1. 7 |
| 16 | 4.16 | 3.57 | 3.38 | 3.19 | 3. 1 | 2.42 |
| 17 | 5. 7 | 4.48 | 4.29 | 4.11 | 3.52 | 3.34 |
| 18 | 7.18 | 6.59 | 6.40 | 6.21 | 6. 3 | 5.45 |
| 19 | 9.30 | 9.11 | 8.52 | 8.33 | 8.15 | 7.57 |
| 20 | 10.41 | 10.22 | 10. 3 | 9.44 | 9.27 | 9. 8 |
| 21 | 11.34 | 11.15 | 10.56 | 10.37 | 10.19 | 10. 1 |
| 22 | 13.46 | 13.27 | 13. 8 | 12.50 | 12.31 | 12.13 |
| 23 | 13.54 | 13.35 | 13.16 | 12.58 | 12.39 | 12.21 |
| 24 | 14.57 | 14.38 | 14.19 | 14. 1 | 13.42 | 13.24 |

For every intervening day allow 3¾ minutes.

# TABLE VIII.

## TRANSITS OF 24 OF THE PRINCIPAL FIXED STARS, OVER THE MERIDIAN OF GREENWICH, IN APPARENT TIME.

### SEPTEMBER.

| No. of *. | DAY. 5 | DAY. 10. | DAY. 15. | DAY. 20. | DAY. 25. | DAY. 30. |
|---|---|---|---|---|---|---|
| | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. |
| 1 | 14. 3 | 13.45 | 13.27 | 13. 9 | 12.51 | 12,33 |
| 2 | 14.34 | 14.16 | 13.58 | 13.40 | 13.22 | 13. 4 |
| 3 | 15. 0 | 14.42 | 14.24 | 14. 6 | 13.48 | 13.30 |
| 4 | 17.28 | 17.10 | 16.52 | 16.35 | 16.17 | 15.59 |
| 5 | 18. 6 | 17.48 | 17.30 | 17.12 | 16.54 | 16,36 |
| 6 | 18. 9 | 17.51 | 17.33 | 17.15 | 16.57 | 16.39 |
| 7 | 18.48 | 18.30 | 18.12 | 17.54 | 17.36 | 17.18 |
| 8 | 19.22 | 19. 4 | 18.46 | 18.29 | 18.11 | 17.53 |
| 9 | 19.40 | 19.22 | 19. 4 | 18.46 | 18.28 | 18.10 |
| 10 | 20.25 | 20. 7 | 19.50 | 19.32 | 19.14 | 18.56 |
| 11 | 20.37 | 20.19 | 20. 1 | 19.43 | 19.25 | 19. 7 |
| 12 | 22.21 | 22. 3 | 21.45 | 21.27 | 21. 9 | 20.51 |
| 13 | 23. 1 | 22.43 | 22.25 | 22. 7 | 21.49 | 21.31 |
| 14 | 23.54 | 23.36 | 23.18 | 23. 1 | 22.43 | 22.25 |
| 15 | 0.45 | 0.27 | 0. 9 | 23.48 | 23.30 | 23.12 |
| 16 | 2.21 | 2. 3 | 1.45 | 1.27 | 1. 9 | 0.51 |
| 17 | 3.12 | 2.54 | 2.36 | 2.19 | 2. 1 | 1.43 |
| 18 | 5.23 | 5. 5 | 4.47 | 4.29 | 4.11 | 3.53 |
| 19 | 7.35 | 7.17 | 6.59 | 6.41 | 6.23 | 6. 5 |
| 20 | 8.46 | 8.28 | 8.10 | 7.52 | 7.34 | 7.16 |
| 21 | 9.39 | 9.21 | 9. 3 | 8.45 | 8.27 | 8. 9 |
| 22 | 11.51 | 11.33 | 11.15 | 10.57 | 10.40 | 10.22 |
| 23 | 11.59 | 11.41 | 11.23 | 11. 6 | 10.48 | 10.30 |
| 24 | 13. 3 | 12.45 | 12.27 | 12. 9 | 11.51 | 11.33 |

For every intervening day allow 3¾ minutes.

### OCTOBER.

| No. of *. | DAY. 5 | DAY. 10. | DAY. 15. | DAY. 20. | DAY. 25. | DAY. 30. |
|---|---|---|---|---|---|---|
| | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. |
| 1 | 12.15 | 11.57 | 11.38 | 11.20 | 11. 1 | 10.41 |
| 2 | 12.46 | 12.28 | 12.10 | 11.51 | 11.32 | 11.13 |
| 3 | 13.12 | 12.54 | 12.36 | 12.17 | 11.58 | 11.39 |
| 4 | 15.41 | 15.22 | 15. 4 | 14.45 | 14.26 | 14. 7 |
| 5 | 16.18 | 16. 0 | 15.42 | 15,23 | 15. 4 | 14.45 |
| 6 | 16.21 | 16. 2 | 15.44 | 15.25 | 15. 6 | 14.47 |
| 7 | 17. 0 | 16.42 | 16.23 | 16.05 | 15.46 | 15.27 |
| 8 | 17.34 | 17.16 | 16.58 | 16.39 | 16·20 | 16. 1 |
| 9 | 17.52 | 17.33 | 17.15 | 16.56 | 16.37 | 16.18 |
| 10 | 18.38 | 18.19 | 18. 1 | 17.42 | 17.23 | 17. 4 |
| 11 | 18.49 | 18.30 | 18.12 | 17.53 | 17.34 | 17.15 |
| 12 | 20.33 | 20.15 | 19.56 | 19.87 | 19,18 | 18.59 |
| 13 | 21.13 | 20.55 | 20.36 | 20.17 | 19,58 | 19.39 |
| 14 | 22. 6 | 21.48 | 21.30 | 21.11 | 20,52 | 20.33 |
| 15 | 22.54 | 22.35 | 22.17 | 21.58 | 21.39 | 21.20 |
| 16 | 0.33 | 0.15 | 23.52 | 23.34 | 23,15 | 22.56 |
| 17 | 1.24 | 1. 6 | 0.48 | 0.29 | 0,10 | 23.47 |
| 18 | 3.35 | 3.17 | 2.58 | 2.40 | 2,21 | 2. 2 |
| 19 | 5.47 | 5,29 | 5.10 | 4.52 | 4.33 | 4.14 |
| 20 | 6.58 | 6.40 | 6.21 | 6. 3 | 5,44 | 5.25 |
| 21 | 7.51 | 7.33 | 7.15 | 6.56 | 6.37 | 6.18 |
| 22 | 10. 3 | 9.45 | 9.27 | 9. 8 | 8.49 | 8.30 |
| 23 | 10.12 | 9.53 | 9.35 | 9.16 | 8.57 | 8.38 |
| 24 | 11.15 | 10.56 | 10.38 | 10.19 | 10. 0 | 9.41 |

For every intervening day allow 3¾ minutes.

### NOVEMBER.

| No. of *. | DAY. 5. | DAY. 10. | DAY. 15. | DAY. 20. | DAY. 25. | DAY. 30. |
|---|---|---|---|---|---|---|
| | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. |
| 1 | 10.18 | 9.58 | 9.38 | 9.17 | 8.56 | 8.35 |
| 2 | 10.49 | 10.29 | 10. 9 | 9.48 | 9.27 | 9. 6 |
| 3 | 11.15 | 10.55 | 10.35 | 10.15 | 9.53 | 9.32 |
| 4 | 13.43 | 13.24 | 13. 3 | 12.43 | 12.22 | 12. 0 |
| 5 | 14.21 | 14. 1 | 13.41 | 13.20 | 12.59 | 12.38 |
| 6 | 14.23 | 14. 4 | 13.43 | 13.23 | 13. 2 | 12.40 |
| 7 | 15.03 | 14.43 | 14.22 | 14. 2 | 13.41 | 13.19 |
| 8 | 15.37 | 15.17 | 14·57 | 14.37 | 14.16 | 13.54 |
| 9 | 15.54 | 15.35 | 15.14 | 14.54 | 14.33 | 14,11 |
| 10 | 16.40 | 16.20 | 16. 0 | 15.40 | 15.19 | 14.57 |
| 11 | 16.51 | 16.32 | 16.12 | 15.51 | 15.30 | 15. 8 |
| 12 | 18.36 | 18.16 | 17.56 | 17.35 | 17.14 | 16.53 |
| 13 | 19.15 | 18.56 | 18.36 | 18.15 | 17.54 | 17,32 |
| 14 | 20. 9 | 19.49 | 19.29 | 19. 8 | 18.47 | 18.26 |
| 15 | 20.56 | 20.36 | 20.16 | 19.56 | 19.35 | 19.13 |
| 16 | 22.32 | 22.12 | 21.51 | 21.31 | 21.10 | 20.49 |
| 17 | 23.23 | 23. 4 | 22.43 | 22.23 | 22. 2 | 21.40 |
| 18 | 1.38 | 1.18 | 0.58 | 0.38 | 0.17 | 23.51 |
| 19 | 3.50 | 3.30 | 3.10 | 2.50 | 2.29 | 2. 7 |
| 20 | 5. 1 | 4.41 | 4.21 | 4. 1 | 3.40 | 3.18 |
| 21 | 5.54 | 5.34 | 5.14 | 4.54 | 4.33 | 4.11 |
| 22 | 8. 6 | 7.46 | 7.26 | 7. 6 | 6.45 | 6.23 |
| 23 | 8.14 | 7.54 | 7.34 | 7.14 | 6.53 | 6.31 |
| 24 | 8.17 | 8.58 | 8.38 | 8.17 | 7.56 | 7.35 |

For every intervening day allow 4¼ minutes.

### DECEMBER.

| No. of *. | DAY. 5. | DAY. 10. | DAY. 15. | DAY. 20. | DAY. 25. | DAY. 30. |
|---|---|---|---|---|---|---|
| | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. |
| 1 | 8.13 | 7.51 | 7.29 | 7. 7 | 6.45 | 6.23 |
| 2 | 8.45 | 7.22 | 8. 0 | 7.38 | 7.16 | 6.54 |
| 3 | 9.11 | 8.49 | 8.26 | 8. 4 | 7.42 | 7.20 |
| 4 | 11.39 | 11.16 | 10.54 | 10.32 | 10.10 | 9.48 |
| 5 | 12.16 | 11.54 | 11.32 | 11.10 | 10.48 | 10.26 |
| 6 | 12.19 | 11.56 | 11.34 | 11.12 | 10.50 | 10.28 |
| 7 | 12.58 | 12.36 | 12.14 | 11.52 | 11.30 | 11. 7 |
| 8 | 13.33 | 13.10 | 12.48 | 12.26 | 12. 4 | 11.42 |
| 9 | 13.50 | 13.28 | 13. 6 | 12.43 | 12,21 | 11.59 |
| 10 | 14.36 | 14.13 | 13.51 | 13.29 | 13, 7 | 12.45 |
| 11 | 14.47 | 14.24 | 14. 2 | 13.40 | 13.18 | 12.56 |
| 12 | 16.31 | 16, 9 | 15.47 | 15.24 | 15. 2 | 14.40 |
| 13 | 17.11 | 16,49 | 16.27 | 16. 4 | 15.42 | 15.20 |
| 14 | 18. 4 | 17.42 | 17.20 | 16.58 | 16.36 | 16.14 |
| 15 | 18.52 | 18.30 | 18. 7 | 17.45 | 17.23 | 17. 1 |
| 16 | 20.27 | 20. 5 | 19.43 | 19.21 | 18.59 | 18.36 |
| 17 | 21.19 | 20.56 | 20.34 | 20.12 | 19.50 | 19.28 |
| 18 | 23.29 | 23. 7 | 22.45 | 22.23 | 22. 1 | 21.39 |
| 19 | 1.46 | 1.23 | 1. 1 | 0,39 | 0.17 | 23.51 |
| 20 | 2,57 | 2.34 | 2.12 | 1.50 | 1.28 | 1. 6 |
| 21 | 3.50 | 3.27 | 3. 5 | 2.43 | 2.21 | 1.59 |
| 22 | 6. 2 | 5.39 | 5.17 | 4.55 | 4.33 | 4.11 |
| 23 | 6.10 | 5.48 | 5.26 | 5. 3 | 4.41 | 4.19 |
| 24 | 7.13 | 6.51 | 6.29 | 6. 7 | 5.44 | 5.22 |

For every intervening day allow 4½ minutes.

# TABLE IX.

## TRUE MERIDIAN ALTITUDES OF THE PRINCIPAL FIXED STARS IN NORTH LATITUDE.

| Lat. | STAR No. 1. | STAR No. 2. | STAR No. 3. | STAR No. 4. | STAR No. 5. | STAR No. 6. | STAR No. 7. | STAR No. 8. | STAR No. 9. | STAR No. 10. | STAR No. 11. | STAR No. 12. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ° | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° | ° ′ |
| 0 | 55.18N. | 31.53 S. | 67.22N. | 73.51N. | 44.11N. | 81.35 S. | 82.38N. | 37.24S. | 73.31 S. | 57.44N. | 61.34N. | 82. 6 S. |
| 1 | 56.18 | 30.53 | 68.22 | 74.51 | 45.11 | 80.35 | 83.38 | 36.24 | 72.31 | 58.44 | 62.34 | 81. 6 |
| 2 | 57.18 | 29.53 | 69.22 | 75.51 | 46.11 | 79.35 | 84.38 | 35.24 | 71.31 | 59.44 | 63.34 | 80. 6 |
| 3 | 58.18 | 28.53 | 70.22 | 76.51 | 47.11 | 78.35 | 85.38 | 34.24 | 70.31 | 60.44 | 64.34 | 79. 6 |
| 4 | 59.18 | 27.53 | 71.22 | 77.51 | 48.11 | 77.35 | 86.38 | 33.24 | 69.31 | 61.44 | 65.34 | 78. 6 |
| 5 | 60.18 | 26.53 | 72.22 | 78.51 | 49.11 | 76.35 | 87.38 | 32.24 | 68.31 | 62.44 | 66.34 | 77. 6 |
| 6 | 61.18 | 25.53 | 73.22 | 79.51 | 50.11 | 75.35 | 88.38 | 31.24 | 67.31 | 63.44 | 67.34 | 76. 6 |
| 7 | 62.18 | 24.53 | 74.22 | 80.51 | 51.11 | 74.35 | 89.38N. | 30.24 | 66.31 | 64.44 | 68.34 | 75. 6 |
| 8 | 63.18 | 23.53 | 75.22 | 81.51 | 52.11 | 73.35 | 89.22 S. | 29.24 | 65.31 | 65.44 | 69.34 | 74. 6 |
| 9 | 64.18 | 22.53 | 76.22 | 82.51 | 53.11 | 72.35 | 88.22 | 28.24 | 64.31 | 66.44 | 70.34 | 73. 6 |
| 10 | 65.18 | 21.53 | 77.22 | 83.51 | 54.11 | 71.35 | 87.22 | 27.24 | 63.31 | 67.44 | 71.34 | 72. 6 |
| 11 | 66.18 | 20.53 | 78.22 | 84.51 | 55.11 | 70.35 | 86.22 | 26.24 | 62.31 | 68.44 | 72.34 | 71. 6 |
| 12 | 67.18 | 19·53 | 79.22 | 85.51 | 56.11 | 69.35 | 85.22 | 25.24 | 61.31 | 69.44 | 73.34 | 70. 6 |
| 13 | 68.18 | 18.53 | 80.22 | 86.51 | 57.11 | 68.35 | 84.22 | 24.24 | 60.31 | 70.44 | 74.34 | 69. 6 |
| 14 | 69.18 | 17.53 | 81.22 | 87.51 | 58.11 | 67.35 | 83.22 | 23.24 | 59.31 | 71.44 | 75.34 | 68. 6 |
| 15 | 70.18 | 16.53 | 82.22 | 88.51 | 59.11 | 66.35 | 82.22 | 22.24 | 58.31 | 72.44 | 76.34 | 67. 6 |
| 16 | 71.18 | 15.53 | 83.22 | 89.51N. | 60.11 | 65.35 | 81.22 | 21.24 | 57.31 | 73.44 | 77.34 | 66. 6 |
| 17 | 72.18 | 14.53 | 84.22 | 89. 9S. | 61.11 | 64.35 | 80.22 | 20.24 | 56.31 | 74.44 | 78.34 | 65. 6 |
| 18 | 73.18 | 13.53 | 85.22 | 88. 9 | 62·11 | 63.35 | 79.22 | 19.24 | 55.31 | 75.44 | 79.34 | 64. 6 |
| 19 | 74.18 | 12.53 | 86.22 | 87. 9 | 63.11 | 62.35 | 78.22 | 18.24 | 54.31 | 76.44 | 80.34 | 63. 6 |
| 20 | 75.18 | 11.53 | 87.22 | 86. 9 | 64.11 | 61.35 | 77.22 | 17.24 | 53.31 | 77.44 | 81.34 | 62. 6 |
| 21 | 76.18 | 10.53 | 88.22 | 85. 9 | 65.11 | 60.35 | 76.22 | 16.24 | 52.31 | 78.44 | 82.34 | 61. 6 |
| 22 | 77.18 | 9.53 | 89.22N. | 84. 9 | 66.11 | 59.35 | 75.22 | 15.24 | 51.31 | 79.44 | 83.34 | 60. 6 |
| 23 | 78.18 | 8.53 | 89.38 S. | 83. 9 | 67.11 | 58.35 | 74.22 | 14.24 | 50.31 | 80.44 | 84.34 | 59. 6 |
| 24 | 79.18 | 7.53 | 88.38 | 82. 9 | 68.11 | 57.35 | 73.22 | 13.24 | 49.31 | 81.44 | 85.34 | 58. 6 |
| 25 | 80.18 | 6·53 | 87.38 | 81. 9 | 69.11 | 56.35 | 72.22 | 12.24 | 48.31 | 82.44 | 86.34 | 57. 6 |
| 26 | 81.18 | 5.53 | 86.38 | 80. 9 | 70.11 | 55.35 | 71.22 | 11.24 | 47.31 | 83.44 | 87.34 | 56. 6 |
| 27 | 82.18 | 4.53 | 85.38 | 79. 9 | 71.11 | 54.35 | 70.22 | 10.24 | 46.31 | 84.44 | 88.34 | 55. 6 |
| 28 | 83.18 | 3.53 | 84.38 | 78. 9 | 72.11 | 53.35 | 69.22 | 9.24 | 45.31 | 85.44 | 89.34 | 54. 6 |
| 29 | 84.18 | 2.53 | 83.38 | 77. 9 | 73.11 | 52.35 | 68.22 | 8.24 | 44.31 | 86.44 | 89.34 | 53. 6 |
| 30 | 85.18 | 1.53 | 82.38 | 76. 9 | 74.11 | 51.35 | 67.22 | 7.24 | 43.31 | 87.44 | 88.34 | 52. 6 |
| 31 | 86.18 | 0.53 | 81.38 | 75. 9 | 75.11 | 50.35 | 66.22 | 6.24 | 42.31 | 88.44 | 87.34 | 51. 6 |
| 32 | 87.18 | Below the Horizon. | 80.38 | 74. 9 | 76.11 | 49.35 | 65.22 | 5.24 | 41.31 | 89.44N. | 86.34 | 50. 6 |
| 33 | 88.18 | | 79.38 | 73. 9 | 77.11 | 48.35 | 64.22 | 4.24 | 40.31 | 89.16 S. | 85.26 | 49. 6 |
| 34 | 89.18N. | | 78.38 | 72. 9 | 78.11 | 47.35 | 63.22 | 3.24 | 39.31 | 88.16 | 84.26 | 48. 6 |
| 35 | 89.42 S. | | 77.38 | 71. 9 | 79.11 | 46.35 | 62.22 | 2.24 | 38.31 | 87.16 | 83.26 | 47. 6 |
| 36 | 88.42 | | 76.38 | 70. 9 | 80.11 | 45.35 | 61.22 | 1.24 | 37.31 | 86.16 | 82.26 | 46. 6 |
| 37 | 87.42 | | 75.38 | 69. 9 | 81.11 | 44.35 | 60.22 | 0.24 | 36.31 | 85.16 | 81.26 | 45. 6 |
| 38 | 86.42 | | 74.38 | 68. 9 | 82.11 | 43.35 | 59.22 | Below the Horizon. | 35.31 | 84.16 | 80.26 | 44. 6 |
| 39 | 85.42 | | 73.38 | 67. 9 | 83.11 | 42.35 | 58.22 | | 34.31 | 83.16 | 79.26 | 43. 6 |
| 40 | 84.42 | | 72.38 | 66. 9 | 84.11 | 41.35 | 57.22 | | 33.31 | 82.16 | 78.26 | 42. 6 |
| 41 | 83.42 | | 71.38 | 65. 9 | 85.11 | 40.35 | 56.22 | | 32.31 | 81.16 | 77.26 | 41. 6 |
| 42 | 82.42 | | 70.38 | 64. 9 | 86.11 | 39.35 | 55.22 | | 31.31 | 80.16 | 76.26 | 40. 6 |
| 43 | 81.42 | | 69.38 | 63. 9 | 87.11 | 38.35 | 54.22 | | 30.31 | 79.16 | 75.26 | 39. 6 |
| 44 | 80.42 | | 68.38 | 62. 9 | 88.11 | 37.35 | 53.22 | | 29.31 | 78.16 | 74.26 | 38. 6 |
| 45 | 79.42 | | 67.38 | 61. 9 | 89.11N. | 36.35 | 52.22 | | 28.31 | 77.16 | 73.26 | 37. 6 |
| 46 | 78.42 | | 66.38 | 60. 9 | 89.49 S. | 35.35 | 51.22 | | 27.31 | 76.16 | 72.26 | 36. 6 |
| 47 | 77.42 | | 65.38 | 59. 9 | 88.49 | 34.35 | 50.52 | | 26.31 | 75.16 | 71.26 | 35. 6 |
| 48 | 76.42 | | 64.38 | 58. 9 | 87.49 | 33.35 | 49.22 | | 25.31 | 74.16 | 70.26 | 34. 6 |
| 49 | 75.42 | | 63.38 | 57. 9 | 86.49 | 32.35 | 48.22 | | 24.31 | 73.16 | 69.26 | 33. 6 |
| 50 | 74.42 | | 62.38 | 56. 9 | 85.49 | 31.35 | 47.22 | | 23.31 | 72.16 | 68.26 | 32. 6 |
| 51 | 73.42 | | 61.38 | 55. 9 | 84.49 | 30.35 | 46.22 | | 22.31 | 71.16 | 67.26 | 31. 6 |
| 52 | 72.42 | | 60.38 | 54. 9 | 83.49 | 29.35 | 45.22 | | 21.31 | 70.16 | 66.26 | 30. 6 |
| 53 | 71.42 | | 59.38 | 53. 9 | 82.49 | 28.35 | 44.22 | | 20.31 | 69.16 | 65.26 | 29. 6 |
| 54 | 70.42 | | 58.38 | 52. 9 | 81.49 | 27.35 | 43.22 | | 19.31 | 68.16 | 64.26 | 28. 6 |
| 55 | 69.42 | | 57.38 | 51. 9 | 80.49 | 26.35 | 42.22 | | 18.31 | 67.16 | 63.26 | 27. 6 |
| 56 | 68.42 | | 56.38 | 50. 9 | 79.49 | 25.35 | 41.22 | | 17.31 | 66.16 | 62.26 | 26. 6 |
| 57 | 67.42 | | 55.38 | 49. 9 | 78.49 | 24.35 | 40.22 | | 16.31 | 65.16 | 61.26 | 25. 6 |
| 58 | 66.42 | | 54.38 | 48. 9 | 77.49 | 23.35 | 39.22 | | 15.31 | 64.16 | 60.26 | 24. 6 |
| 59 | 65.42 | | 53.38 | 47. 9 | 76.49 | 22.35 | 38.22 | | 14.31 | 63.16 | 59.26 | 23. 6 |
| 60 | 64.42 | | 52.38 | 46. 9 | 75.49 | 21.35 | 37.22 | | 13.31 | 62.16 | 58.26 | 22. 6 |

# TABLE IX.

## TRUE MERIDIAN ALTITUDES OF THE PRINCIPAL FIXED STARS IN NORTH LATITUDE.

| Lat. | STAR No. 13. | STAR No. 14. | STAR No. 15. | STAR No. 16. | STAR No. 17. | STAR No. 18. | STAR No. 19. | STAR No. 20. | STAR No. 21. | STAR No. 22. | STAR No. 23. | STAR No. 24. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ |
| 0 | 77.10N. | 28.19N. | 74.27N. | 79.45 S. | 69.54N. | 63.58 S. | 51.23N. | 81.35N. | 45.20N. | 59.27 S. | 75.44N. | 61.52N. |
| 1 | 78.10 | 29.19 | 75.27 | 78.45 | 70.54 | 62.58 | 52.23 | 82.35 | 46.20 | 58.27 | 76.44 | 62.52 |
| 2 | 79.10 | 30.19 | 76.27 | 77.45 | 71.54 | 61.58 | 53.23 | 83.35 | 47.20 | 57.27 | 77.44 | 63.52 |
| 3 | 80.10 | 31.19 | 77.27 | 76.45 | 72.54 | 60.58 | 54.23 | 84.35 | 48.20 | 56.27 | 78.44 | 64.52 |
| 4 | 81.10 | 32.19 | 78.27 | 75.45 | 73.54 | 59.58 | 55.23 | 85.35 | 49.20 | 55.27 | 79.44 | 65.52 |
| 5 | 82.10 | 33.19 | 79.27 | 74.45 | 74.54 | 58.58 | 56.23 | 86.35 | 50.20 | 54.27 | 80.44 | 66.52 |
| 6 | 83.10 | 34.19 | 80.27 | 73.45 | 75.54 | 57.58 | 57.23 | 87.35 | 51.20 | 53.27 | 81.44 | 67.52 |
| 7 | 84.10 | 35.19 | 81.27 | 72.45 | 76.54 | 56.58 | 58.23 | 88.35 | 52.20 | 52.27 | 82.44 | 68.52 |
| 8 | 85.10 | 36.19 | 82.27 | 71.45 | 77·54 | 55.58 | 59.23 | 89.35 N. | 53.20 | 51.27 | 83.44 | 69.52 |
| 9 | 86.10 | 37.19 | 83.27 | 70.45 | 78.54 | 54.58 | 60.23 | 89.25 S. | 54.20 | 50.27 | 84.44 | 70.52 |
| 10 | 87.10 | 38.19 | 84.27 | 69.45 | 79.54 | 53.58 | 61.23 | 88.25 | 55.20 | 49.27 | 85.44 | 71.52 |
| 11 | 88.10 | 39.19 | 85.27 | 68.45 | 80.54 | 52.58 | 62.23 | 87.25 | 56.20 | 48.27 | 86.44 | 72.52 |
| 12 | 89.10N. | 40.19 | 86.27 | 67.45 | 81.54 | 51.58 | 63.23 | 86.25 | 57.20 | 47.27 | 87.44 | 73.52 |
| 13 | 89.50 S. | 41.19 | 87.27 | 66.45 | 82.54 | 50.58 | 64.23 | 85.25 | 58.20 | 46.27 | 88.44 | 74.52 |
| 14 | 88.50 | 42.19 | 88.27 | 65.45 | 83.54 | 49.58 | 65.23 | 84.25 | 59.20 | 45.27 | 89.44N. | 75.52 |
| 15 | 87.50 | 43.19 | 89.27N | 64.45 | 84.54 | 48.58 | 66.23 | 83.25 | 60.20 | 44.27 | 89.16 S. | 76.52 |
| 16 | 86.50 | 44.19 | 89.33 S. | 63.45 | 85.54 | 47.58 | 67.23 | 82.25 | 61.20 | 43.27 | 88.16 | 77.52 |
| 17 | 85.50 | 45.19 | 88.33 | 62.45 | 86.54 | 46.58 | 68.23 | 81.25 | 62.20 | 42.27 | 87.16 | 78.52 |
| 18 | 84.50 | 46.19 | 87.33 | 61.45 | 87.54 | 45.58 | 69.23 | 80.25 | 63.20 | 41.27 | 86.16 | 79.52 |
| 19 | 83.50 | 47.19 | 86.33 | 60.45 | 88.54 | 44.58 | 70.23 | 79.25 | 64.20 | 40.27 | 85.16 | 80.52 |
| 20 | 82.50 | 48.19 | 85.33 | 59.45 | 89.54N. | 43.58 | 71.23 | 78.25 | 65.20 | 39.27 | 84.16 | 81.52 |
| 21 | 81.50 | 49.19 | 84.33 | 58.45 | 89. 6 S. | 42.58 | 72.23 | 77.25 | 66.20 | 38.27 | 83.16 | 82.52 |
| 22 | 80.50 | 50.19 | 83.33 | 57.45 | 88. 6 | 41.58 | 73.23 | 76.25 | 67.20 | 37.27 | 82.16 | 83.52 |
| 23 | 79.50 | 51.19 | 82.33 | 56.45 | 87. 6 | 40.58 | 74.23 | 75.25 | 68.20 | 36.27 | 81.16 | 84.52 |
| 24 | 78.50 | 52.19 | 81.33 | 55.45 | 86. 6 | 39.58 | 75.23 | 74.25 | 69.20 | 35.27 | 80.16 | 85.52 |
| 25 | 77.50 | 53.19 | 80.33 | 54.45 | 85. 6 | 38.58 | 76.23 | 73.25 | 70.20 | 34.27 | 79.16 | 86.52 |
| 26 | 76.50 | 54.19 | 79.33 | 53.45 | 84. 6 | 37.58 | 77.23 | 72.25 | 71.20 | 33.27 | 78.16 | 87.52 |
| 27 | 75.50 | 55.19 | 78.33 | 52.45 | 83. 6 | 36.58 | 78.23 | 71.25 | 72.20 | 32.27 | 77.16 | 88.52 |
| 28 | 74.50 | 56.19 | 77.33 | 51.45 | 82. 6 | 35.58 | 79.23 | 70.25 | 73.20 | 31.27 | 76.16 | 89.52N. |
| 29 | 73.50 | 57.19 | 76.33 | 50.45 | 81. 6 | 34.58 | 80.23 | 69.25 | 74.20 | 30.27 | 75.16 | 89. 8 S |
| 30 | 72.50 | 58.19 | 75.33 | 49.45 | 80. 6 | 33.58 | 81.23 | 68.25 | 75.20 | 29.27 | 74.16 | 88. 8 |
| 31 | 71.50 | 59.19 | 74.33 | 48.45 | 79. 6 | 32.58 | 82.23 | 67.25 | 76.20 | 28.27 | 73.16 | 87. 8 |
| 32 | 70.50 | 60.19 | 73.33 | 47.45 | 78. 6 | 31.58 | 83.23 | 66.25 | 77.20 | 27.27 | 72.16 | 86. 8 |
| 33 | 69.50 | 61.19 | 72.33 | 46.45 | 77. 6 | 30.58 | 84.23 | 65.25 | 78.20 | 26.27 | 71.16 | 85. 8 |
| 34 | 68.50 | 62.19 | 71.33 | 45.45 | 76. 6 | 29.58 | 85.23 | 64.25 | 79.20 | 25.27 | 70.16 | 84. 8 |
| 35 | 67.50 | 63.19 | 70.33 | 44.45 | 75. 6 | 28.58 | 86.23 | 63.25 | 80.20 | 24.27 | 69.16 | 83. 8 |
| 36 | 66.50 | 64.19 | 69.33 | 43.45 | 74. 6 | 27.58 | 87.23 | 62.25 | 81.20 | 23.27 | 68.16 | 82. 8 |
| 37 | 65.50 | 65.19 | 68.33 | 42.45 | 73. 6 | 26.58 | 88.23 | 61.25 | 82.20 | 22.27 | 67.16 | 81. 8 |
| 38 | 64.50 | 66.19 | 67.33 | 41.45 | 72. 6 | 25.58 | 89.23N. | 60.25 | 83.20 | 21.27 | 66.16 | 80. 8 |
| 39 | 63.50 | 67.19 | 66.33 | 40.45 | 71. 6 | 24.58 | 89.37 S. | 59.25 | 84.20 | 20.27 | 65.16 | 79. 8 |
| 40 | 62.50 | 68.19 | 65.33 | 39.45 | 70. 6 | 23.58 | 88.37 | 58.25 | 85.20 | 19.27 | 64.16 | 78. 8 |
| 41 | 61.50 | 69.19 | 64.33 | 38.45 | 69. 6 | 22.58 | 87.37 | 57.25 | 86.20 | 18.27 | 63.16 | 77 8 |
| 42 | 60.50 | 70.19 | 63.33 | 37.45 | 68. 6 | 21.58 | 86.37 | 56.25 | 87.20 | 17.27 | 62.16 | 76. 8 |
| 43 | 59.50 | 71.19 | 62.33 | 36.45 | 67. 6 | 20.58 | 85.37 | 55.25 | 88.20 | 16.27 | 61.16 | 75. 8 |
| 44 | 58.40 | 72.19 | 61.33 | 35.45 | 66. 6 | 19.58 | 84.37 | 54.25 | 89.20N. | 15.27 | 60.16 | 74. 8 |
| 45 | 57.50 | 73.19 | 60.33 | 34.45 | 65. 6 | 18.58 | 83.37 | 53.25 | 89.40 S. | 14.27 | 59.16 | 73. 8 |
| 46 | 56.50 | 74.19 | 59.33 | 33.45 | 64. 6 | 17.58 | 82.37 | 52.25 | 88.40 | 13.27 | 58.16 | 72. 8 |
| 47 | 55.50 | 75.19 | 58.33 | 32.45 | 63. 6 | 16.58 | 81.37 | 51.25 | 87.40 | 12.27 | 57.16 | 71. 8 |
| 48 | 54.50 | 76.19 | 57.33 | 31.45 | 62. 6 | 15.58 | 80.37 | 50.25 | 86.40 | 11.27 | 56.16 | 70. 8 |
| 49 | 53.50 | 77.19 | 56.33 | 30.45 | 61. 6 | 14.58 | 79.37 | 49.25 | 85.40 | 10.27 | 55.16 | 69. 8 |
| 50 | 52.50 | 78.19 | 55.33 | 29.45 | 60. 6 | 13.58 | 78.37 | 48.25 | 84.40 | 9.27 | 54.16 | 68. 8 |
| 51 | 51.50 | 79.19 | 54.33 | 28.45 | 59. 6 | 12.58 | 77.37 | 47.25 | 83.40 | 8.27 | 53.16 | 67. 8 |
| 52 | 50.50 | 80.19 | 53.33 | 27.45 | 58. 6 | 11.58 | 76.37 | 46.25 | 82.40 | 7.27 | 52.16 | 66. 8 |
| 53 | 49.50 | 81.19 | 52.33 | 26.45 | 57. 6 | 10.58 | 75.37 | 45.25 | 81.40 | 6.27 | 51.16 | 65. 8 |
| 54 | 48.50 | 82.19 | 51.33 | 25.45 | 56. 6 | 9.58 | 74.37 | 44.25 | 80.40 | 5.27 | 50.16 | 64. 8 |
| 55 | 47.50 | 83.19 | 50.33 | 24.45 | 55. 6 | 8.58 | 73.37 | 43.25 | 79.40 | 4.27 | 49.16 | 63. 8 |
| 56 | 46.50 | 84.19 | 49.33 | 23.45 | 54. 6 | 7.58 | 72.38 | 42.25 | 78.40 | 3.27 | 48.16 | 62. 8 |
| 57 | 45.50 | 85.19 | 48.33 | 22.45 | 53. 6 | 6.58 | 71.37 | 41.25 | 77.40 | 2.27 | 47.16 | 61. 8 |
| 58 | 44.50 | 86.19 | 47.33 | 21.45 | 52. 6 | 5.58 | 70.37 | 40.25 | 76.40 | 1.27 | 46.16 | 60. 8 |
| 59 | 43.50 | 87.19 | 46.33 | 20.45 | 51. 6 | 4.58 | 69.37 | 39.25 | 75.40 | 0.27 | 45.16 | 59. 8 |
| 60 | 42.50 | 88.19 | 45.33 | 19.45 | 50. 6 | 3.58 | 68.37 | 38.25 | 74.40 |  | 44.16 | 58. 8 |

# TABLE X.

## TRUE MERIDIAN ALTITUDES OF THE PRINCIPAL FIXED STARS IN SOUTH LATITUDE.

| Lat. | STAR No. 1. | STAR No. 2. | STAR No. 3. | STAR No. 4. | STAR No. 5. | STAR No. 6. | STAR No. 7. | STAR No. 8. | STAR No. 9. | STAR No. 10. | STAR No. 11. | STAR No. 12. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ° ′ | ° ′ | ° | ° ′ | ° | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° | ° |
| 0 | 55.18 N. | 31.53 S. | 67.22 N. | 73.51 N. | 44.11 N. | 81.35 S. | 82.38 N. | 37.24 S. | 73.31 S. | 57.44 N. | 61.34 N. | 82. 6 S. |
| 1 | 54.18 | 32.53 | 66.22 | 72.51 | 43.11 | 82.35 | 81.38 | 38.24 | 74.31 | 56.44 | 60.34 | 83. 6 |
| 2 | 53.18 | 33.53 | 65.22 | 71.51 | 42.11 | 83.35 | 80.38 | 39.24 | 75.31 | 55.44 | 59.34 | 84. 6 |
| 3 | 52.18 | 34.53 | 64.22 | 70.51 | 41.11 | 84.35 | 79.38 | 40.24 | 76.31 | 54.44 | 58.34 | 85. 6 |
| 4 | 51.18 | 35.53 | 63.22 | 69.51 | 40.11 | 85.35 | 78.38 | 41.24 | 77.31 | 53.44 | 57.34 | 86. 6 |
| 5 | 50.18 | 36.53 | 62.22 | 68.51 | 39.11 | 86.35 | 77.38 | 42.24 | 78.31 | 52.44 | 56.34 | 87. 6 |
| 6 | 49.18 | 37.53 | 61.22 | 67.51 | 38.11 | 87.35 | 76.38 | 43.24 | 79.31 | 51.44 | 55.34 | 88. 6 |
| 7 | 48.18 | 38.53 | 60.22 | 66.51 | 37.11 | 88.35 | 75.38 | 44.24 | 80.31 | 50.44 | 54.34 | 89. 6 S. |
| 8 | 47.18 | 39.53 | 59.22 | 65.51 | 36.11 | 89.35 S. | 74.38 | 45.24 | 81.31 | 49.44 | 53.34 | 89.54 N. |
| 9 | 46.18 | 40.53 | 58.22 | 64.51 | 35.11 | 89.25 N. | 73.38 | 46.24 | 82.31 | 48.44 | 52.34 | 88.54 |
| 10 | 45.18 | 41.53 | 57.22 | 63.51 | 34.11 | 88.25 | 72.38 | 47.24 | 83.31 | 47.44 | 51.34 | 87.54 |
| 11 | 44.18 | 42.53 | 56.22 | 62.51 | 33.11 | 87.25 | 71.38 | 48.24 | 84.31 | 46.44 | 50.34 | 86.54 |
| 12 | 43.18 | 43.53 | 55.22 | 61.51 | 32.11 | 86.25 | 70.38 | 49.24 | 85.31 | 45.44 | 49.34 | 85.54 |
| 13 | 42.18 | 44.53 | 54.22 | 60.51 | 31.11 | 85.25 | 69.38 | 50.24 | 86.31 | 44.44 | 48.34 | 84.54 |
| 14 | 41.18 | 45.53 | 53.22 | 59.51 | 30.11 | 84.25 | 68.38 | 51.24 | 87.31 | 43.44 | 47.34 | 83.54 |
| 15 | 40.18 | 46.53 | 52.22 | 58.51 | 29.11 | 83.25 | 67.38 | 52.24 | 88.31 | 42.44 | 46.34 | 82.54 |
| 16 | 39.18 | 47.53 | 51.22 | 57.51 | 28.11 | 82.25 | 66.38 | 53.24 | 89.31 S. | 41.44 | 45.34 | 81.54 |
| 17 | 38.18 | 48.53 | 50.22 | 56.51 | 27.11 | 81.25 | 65.38 | 54.24 | 89.29 N. | 40.44 | 44.34 | 80.54 |
| 18 | 37.18 | 49.53 | 49.22 | 55.51 | 26.11 | 80.25 | 64.38 | 55.24 | 88.29 | 39.44 | 43.34 | 79.54 |
| 19 | 36.18 | 50.53 | 48.22 | 54.51 | 25.11 | 79.25 | 63.38 | 56.24 | 87.29 | 38.44 | 42.34 | 78.54 |
| 20 | 35.18 | 51.53 | 47.22 | 53.51 | 24.11 | 78.25 | 62.38 | 57.24 | 86.29 | 37.44 | 41.34 | 77.54 |
| 21 | 34.18 | 52.53 | 46.22 | 52.51 | 23.11 | 77.25 | 61.38 | 58.24 | 85.29 | 36.44 | 40.34 | 76.54 |
| 22 | 33.18 | 53.53 | 45.22 | 51.51 | 22.11 | 76.25 | 60.38 | 59.24 | 84.29 | 35.44 | 39.34 | 75.54 |
| 23 | 32.18 | 54.53 | 44.22 | 50.51 | 21.11 | 75.25 | 59.38 | 60.24 | 83.29 | 34.44 | 38.34 | 74.54 |
| 24 | 31.18 | 55.53 | 43.22 | 49.51 | 20.11 | 74.25 | 58.38 | 61.24 | 82.29 | 33.44 | 37.34 | 73.54 |
| 25 | 30.18 | 56.53 | 42.22 | 48.51 | 19.11 | 73.25 | 57.38 | 62.24 | 81.29 | 32.44 | 36.34 | 72.54 |
| 26 | 29.18 | 57.53 | 41.22 | 47.51 | 18.11 | 72.25 | 56.38 | 63.24 | 80.29 | 31.44 | 35.34 | 71.54 |
| 27 | 28.18 | 58.53 | 40.22 | 46.51 | 17.11 | 71 25 | 55.38 | 64.24 | 79.29 | 30.44 | 34.34 | 70.54 |
| 28 | 27.18 | 59.53 | 39.22 | 45.51 | 16.11 | 70.25 | 54.38 | 65.24 | 78.29 | 29.44 | 33.34 | 69.54 |
| 29 | 26.18 | 60.53 | 38.22 | 44.51 | 15.11 | 69.25 | 53.38 | 66.24 | 77.29 | 28.44 | 32.34 | 68.54 |
| 30 | 25.18 | 61.53 | 37.22 | 43.51 | 14.11 | 68.25 | 52.38 | 67.24 | 76.29 | 27.44 | 31.34 | 67.54 |
| 31 | 24.18 | 62.53 | 36.22 | 42.51 | 13.11 | 67.25 | 51.38 | 68.24 | 75.29 | 26.44 | 30.34 | 66.54 |
| 32 | 23.18 | 63.53 | 35.22 | 41.51 | 12.11 | 66.25 | 50.38 | 69.24 | 74.29 | 25.44 | 29.34 | 65.54 |
| 33 | 22.18 | 64.53 | 34.22 | 40.51 | 11.11 | 65.25 | 49.38 | 70.24 | 73.29 | 24.44 | 28.34 | 64.54 |
| 34 | 21.18 | 65.53 | 33.22 | 39.51 | 10.11 | 64.25 | 48.38 | 71.24 | 72.29 | 23.44 | 27.34 | 63.54 |
| 35 | 20.18 | 66.53 | 32.22 | 38.51 | 9.11 | 63.25 | 47.38 | 72.24 | 71.29 | 22.44 | 26.34 | 62.54 |
| 36 | 19.18 | 67.53 | 31.22 | 37.51 | 8.11 | 62.25 | 46.38 | 73.24 | 70.29 | 21.44 | 25.34 | 61.54 |
| 37 | 18.18 | 68.53 | 30.22 | 36.51 | 7.11 | 61.25 | 45.38 | 74.24 | 69.29 | 20.44 | 24.34 | 60.54 |
| 38 | 17.18 | 69.53 | 29.22 | 35.51 | 6.11 | 60.25 | 44.38 | 75.24 | 68.29 | 19.44 | 23.34 | 59.54 |
| 39 | 16.18 | 70.53 | 28.22 | 34.51 | 5.11 | 59.25 | 43.38 | 76.24 | 67.29 | 18.44 | 22.34 | 58.54 |
| 40 | 15.18 | 71.53 | 27.22 | 33.51 | 4.11 | 58.25 | 42.38 | 77.24 | 66.29 | 17.44 | 21.34 | 57.54 |
| 41 | 14.18 | 72.53 | 26.22 | 32.51 | 3.11 | 57.25 | 41.38 | 78.24 | 65.29 | 16.44 | 20.34 | 56.54 |
| 42 | 13.18 | 73.53 | 25.22 | 31.51 | 2.11 | 56.25 | 40.38 | 79.24 | 64.29 | 15.44 | 19.34 | 55.54 |
| 43 | 12.18 | 74.53 | 24.22 | 30.51 | 1.11 | 55.25 | 39.38 | 80.24 | 63.29 | 14.44 | 18.34 | 54.54 |
| 44 | 11.18 | 75.53 | 23.22 | 29.51 | 0.11 | 54.25 | 38.38 | 81.24 | 62.29 | 13.44 | 17.34 | 53.54 |
| 45 | 10.18 | 76.53 | 22.22 | 28.51 | Below the Horizon. | 53.25 | 37.38 | 82.24 | 61.39 | 12.44 | 16.34 | 52.54 |
| 46 | 9.18 | 77.53 | 21.22 | 27.51 |  | 52.25 | 36.38 | 83.24 | 60.29 | 11.44 | 15.34 | 51.54 |
| 47 | 8.18 | 78.53 | 20.22 | 26.51 |  | 51.25 | 35.38 | 84.24 | 59.29 | 10.44 | 14.34 | 50.54 |
| 48 | 7.18 | 79.53 | 19.22 | 25.51 |  | 50.25 | 34.38 | 85.24 | 58.29 | 9.44 | 13.34 | 49.54 |
| 49 | 6.18 | 80.53 | 18.22 | 24.51 |  | 49.25 | 33.38 | 86.24 | 57.29 | 8.44 | 12.34 | 48.54 |
| 50 | 5.18 | 81 53 | 17.22 | 23.51 |  | 48.25 | 32.38 | 87.24 | 56.29 | 7.44 | 11.34 | 47.54 |
| 51 | 4.18 | 82.53 | 16.22 | 22.51 |  | 47.25 | 31.38 | 88.24 | 55.29 | 6.44 | 10.34 | 46.54 |
| 52 | 3.18 | 83.53 | 15.22 | 21.51 |  | 46.25 | 30.38 | 89.24 N. | 54.29 | 5.44 | 9.34 | 45.54 |
| 53 | 2.18 | 84.53 | 14.22 | 20.51 |  | 45.25 | 29.38 | 89.36 S. | 53.29 | 4.44 | 8.34 | 44.54 |
| 54 | 1.18 | 85.53 | 13.22 | 19.51 |  | 44.25 | 28.38 | 88.36 | 52.29 | 3.44 | 7.34 | 43.54 |
| 55 | 0.18 | 86.53 | 12.22 | 18.51 |  | 43.25 | 27.38 | 87.36 | 51.29 | 2.44 | 6.34 | 42.54 |
| 56 | Below the Horizon | 87.53 | 11.22 | 17.51 |  | 42.25 | 26.38 | 86.36 | 50.29 | 1.44 | 5.34 | 41.54 |
| 57 |  | 88.53 | 10.22 | 16.51 |  | 41.25 | 25.38 | 85.36 | 49.29 | 0.44 | 4.34 | 40.54 |
| 58 |  | 89.53 S. | 9.22 | 15.51 |  | 40.25 | 24.38 | 84.36 | 48.29 | Below the Hor. | 3.34 | 39.54 |
| 59 |  | 89. 7 N. | 8.22 | 14.51 |  | 39.25 | 23.38 | 83.36 | 47.29 |  | 2.34 | 38.54 |
| 60 |  | 88. 7 | 7.22 | 13.51 |  | 38.25 | 22.38 | 82.36 | 46.29 |  | 1.34 | 37.54 |

# TABLE X.

## TRUE MERIDIAN ALTITUDES OF THE PRINCIPAL FIXED STARS IN SOUTH LATITUDE.

| Lat. | STAR No. 13. | STAR No. 14. | STAR No. 15. | STAR No. 16. | STAR No. 17. | STAR No. 18. | STAR No. 19. | STAR No. 20. | STAR No. 21. | STAR No. 22. | STAR No. 23. | STAR No. 24. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ |
| 0 | 77.10N. | 27.19N. | 74.27N. | 79.45 S. | 69.54N. | 63.58 S. | 51.23N. | 81.33N. | 45.20N. | 59.27 S. | 75.44N. | 61.52N. |
| 1 | 76.10 | 26.19 | 73.27 | 80.45 | 68.54 | 64.58 | 50.23 | 80.33 | 44.20 | 60.27 | 74.44 | 60.52 |
| 2 | 75.10 | 25.19 | 72.27 | 81.45 | 67.54 | 65.58 | 49.23 | 79.33 | 43.20 | 61.27 | 73.44 | 59.52 |
| 3 | 74.10 | 24.19 | 71.27 | 82.45 | 66.54 | 66.58 | 48.23 | 78.33 | 42.20 | 62.27 | 72.44 | 58.52 |
| 4 | 73.10 | 23.19 | 70.27 | 83.45 | 65.54 | 67.58 | 47.23 | 77.33 | 41.20 | 63.27 | 71.44 | 57.52 |
| 5 | 72.10 | 22.19 | 69.27 | 84.45 | 64.54 | 68.58 | 46.23 | 76.33 | 40.20 | 64.27 | 70.44 | 56.52 |
| 6 | 71.10 | 21.19 | 68.27 | 85.45 | 63.54 | 69.58 | 45.23 | 75.33 | 39.20 | 65.27 | 69.44 | 55.52 |
| 7 | 70.10 | 20.19 | 67.27 | 86.45 | 62.54 | 70.58 | 44.23 | 74.33 | 38.20 | 66.27 | 68.44 | 54.52 |
| 8 | 69.10 | 19.19 | 66.27 | 87.45 | 61.54 | 71.58 | 43.23 | 73.33 | 37.20 | 67.27 | 67.44 | 53.52 |
| 9 | 68.10 | 18.19 | 65.27 | 88.45 | 60.54 | 72.58 | 42.23 | 72.33 | 36.20 | 68.27 | 66.44 | 52.52 |
| 10 | 67.10 | 17.19 | 64.27 | 89.45 S. | 59.54 | 73.58 | 41.23 | 71.33 | 35.20 | 69.27 | 65.44 | 51.52 |
| 11 | 66.10 | 16.19 | 63.27 | 89.15N. | 58.54 | 74.58 | 40.23 | 70.33 | 34.20 | 70.27 | 64.44 | 50.52 |
| 12 | 65.10 | 15.19 | 62.27 | 88.15 | 57.54 | 75.58 | 39.23 | 69.33 | 33.20 | 71.27 | 63.44 | 49.52 |
| 13 | 64.10 | 14.19 | 61.27 | 87.15 | 56.54 | 76.58 | 38.23 | 68.33 | 32.20 | 72.27 | 62.44 | 48.52 |
| 14 | 63.10 | 13.19 | 60.27 | 86.15 | 55.54 | 77.58 | 37.23 | 67.33 | 31.20 | 73.27 | 61.44 | 47.52 |
| 15 | 62.10 | 12.19 | 59.27 | 85.15 | 54.54 | 78.58 | 36.23 | 66.33 | 30.20 | 74.27 | 60.44 | 46.52 |
| 16 | 61.10 | 11.19 | 58.27 | 84.15 | 53.54 | 79.58 | 35.23 | 65.33 | 29.20 | 75.27 | 59.44 | 45.52 |
| 17 | 60.10 | 10.19 | 57.27 | 83.15 | 52.54 | 80.58 | 34.23 | 64.33 | 28.20 | 76.27 | 58.44 | 44.52 |
| 18 | 59.10 | 9.19 | 56.27 | 82.15 | 51.54 | 81.58 | 33.23 | 63.33 | 27.20 | 77.27 | 57.44 | 43.52 |
| 19 | 58.10 | 8.19 | 55.27 | 81.15 | 50.54 | 82.58 | 32.23 | 62.33 | 26.20 | 78.27 | 56.44 | 42.52 |
| 20 | 57.10 | 7.19 | 54.27 | 80.15 | 49.54 | 83.58 | 31.23 | 61.33 | 25.20 | 79.27 | 55.44 | 41.52 |
| 21 | 56.10 | 6.19 | 53.27 | 79.15 | 48.54 | 84.58 | 30.23 | 60.33 | 24.20 | 80.27 | 54.44 | 40.52 |
| 22 | 55.10 | 5.19 | 52.27 | 78.15 | 47.54 | 85.58 | 29.23 | 59.33 | 23.20 | 81.27 | 53.44 | 39.52 |
| 23 | 54.10 | 4.19 | 51.27 | 77.15 | 46.54 | 86.58 | 28.23 | 58.33 | 22.20 | 82.27 | 52.44 | 38.52 |
| 24 | 53.10 | 3.19 | 50.27 | 76.15 | 45.54 | 87.58 | 27.23 | 57.33 | 21.20 | 83.27 | 51.44 | 37.52 |
| 25 | 52.10 | 2.19 | 49.27 | 75.15 | 44.54 | 88.58 | 26.23 | 56.33 | 20.20 | 84.27 | 50.44 | 36.52 |
| 26 | 51.10 | 1.19 | 48.27 | 74.15 | 43.54 | 89.58 S. | 25.23 | 55.33 | 19.20 | 85 27 | 49.44 | 35.52 |
| 27 | 50.10 | 0.19 | 47.27 | 73.15 | 42.54 | 89. 2N. | 24.23 | 54.33 | 18.20 | 86.27 | 48.44 | 34.52 |
| 28 | 49.10 | Below the Horizon. | 46.27 | 72.15 | 41.54 | 88. 2 | 23.23 | 53.33 | 17.20 | 87.27 | 47.44 | 33.52 |
| 29 | 48.10 |  | 45.27 | 71.15 | 40.54 | 87. 2 | 22.33 | 52.33 | 16.20 | 88.27 | 46.44 | 32.52 |
| 30 | 47.10 |  | 44.27 | 70.15 | 39.54 | 86. 2 | 21.23 | 51.33 | 15.20 | 89.27 S. | 45.44 | 31.52 |
| 31 | 46.10 |  | 43.27 | 69.15 | 38.54 | 85. 2 | 20.23 | 50.33 | 14.20 | 89.33N. | 44.44 | 30.52 |
| 32 | 45.10 |  | 42.27 | 68.15 | 37.54 | 84. 2 | 19.23 | 49.33 | 13.20 | 88.33 | 43.44 | 29.52 |
| 33 | 44.10 |  | 41.27 | 67.15 | 36.54 | 83. 2 | 18.23 | 48.33 | 12.20 | 87.33 | 42.44 | 28.52 |
| 34 | 43.10 |  | 40.27 | 66.15 | 35.54 | 82. 2 | 17.23 | 47.33 | 11.20 | 86.33 | 41.44 | 27.52 |
| 35 | 42.10 |  | 39.27 | 65.15 | 34.54 | 81. 2 | 16.23 | 46.33 | 10.20 | 85.33 | 40.44 | 26.52 |
| 36 | 41.10 |  | 38.27 | 64.15 | 33.54 | 80. 2 | 15.23 | 45.33 | 9.20 | 84.33 | 39.44 | 25.52 |
| 37 | 40.10 |  | 37.27 | 63.15 | 32.54 | 79. 2 | 14.23 | 44.33 | 8.20 | 83.33 | 38.44 | 24.52 |
| 38 | 39.10 |  | 36.27 | 62.15 | 31.54 | 78. 2 | 13.23 | 43.33 | 7.20 | 82.33 | 37.44 | 23.52 |
| 39 | 38.10 |  | 35.27 | 61.15 | 30.54 | 77. 2 | 12.23 | 42.33 | 6.20 | 81.33 | 36.44 | 22.52 |
| 40 | 37.10 |  | 34.27 | 60.15 | 29.54 | 76. 2 | 11.23 | 41.33 | 5.20 | 80.33 | 35.44 | 21.52 |
| 41 | 36.10 |  | 33.27 | 59.15 | 28.54 | 75. 2 | 10.23 | 40.33 | 4.20 | 79.33 | 34.44 | 20.52 |
| 42 | 35.10 |  | 32.27 | 58.15 | 27.54 | 74. 2 | 9.23 | 39.33 | 3.20 | 78.33 | 33.44 | 19.52 |
| 43 | 34.10 |  | 31.27 | 57.15 | 26.54 | 73. 2 | 8.23 | 38.33 | 2.20 | 77.33 | 32.44 | 18.52 |
| 44 | 33.10 |  | 30.27 | 56.15 | 25.54 | 72. 2 | 7.23 | 37.33 | 1.20 | 76.33 | 31.44 | 17.52 |
| 45 | 32.10 |  | 29.27 | 55.15 | 24.54 | 71. 2 | 6.23 | 36.33 | 0.20 | 75.33 | 30.44 | 16.52 |
| 46 | 31.10 |  | 28.27 | 54.15 | 23.54 | 70. 2 | 5.23 | 35.33 | Below the Horizon. | 74.33 | 29.44 | 15.52 |
| 47 | 30.10 |  | 27.27 | 53.15 | 22.54 | 69. 2 | 4.23 | 34.33 |  | 73.33 | 28.44 | 14.52 |
| 48 | 29.10 |  | 26.27 | 52.15 | 21.54 | 68. 2 | 3.23 | 33.33 |  | 72.33 | 27.44 | 13.52 |
| 49 | 28.10 |  | 25.27 | 51.15 | 20.54 | 67. 2 | 2.23 | 32.33 |  | 71.33 | 26.44 | 12.52 |
| 50 | 27.10 |  | 24.27 | 50.15 | 19.54 | 66. 2 | 1.23 | 31.33 |  | 70.33 | 25.44 | 11.52 |
| 51 | 26.10 |  | 23.27 | 49.15 | 18.54 | 65. 2 | 0.23 | 30.33 |  | 69.33 | 24.44 | 10.52 |
| 52 | 25.10 |  | 22.27 | 48.15 | 17.54 | 64. 2 | Below the Horizon. | 29.33 |  | 68.33 | 23.44 | 9.52 |
| 53 | 24.10 |  | 21.27 | 47.15 | 16.54 | 63. 2 |  | 28.33 |  | 67.33 | 22.44 | 8.52 |
| 54 | 23.10 |  | 20.27 | 46.15 | 15.54 | 62. 2 |  | 27.33 |  | 66.33 | 21.44 | 7.52 |
| 55 | 22.10 |  | 19.27 | 45.15 | 14.54 | 61. 2 |  | 26.33 |  | 65.33 | 20.44 | 6.52 |
| 56 | 21.10 |  | 18.27 | 44.15 | 13.54 | 60. 2 |  | 25.33 |  | 64.33 | 19.44 | 5.52 |
| 57 | 20.10 |  | 17.27 | 43.15 | 12.54 | 59. 2 |  | 24.33 |  | 63.33 | 18.44 | 4.52 |
| 58 | 19.10 |  | 16.27 | 42.15 | 11.54 | 58. 2 |  | 23.33 |  | 62.33 | 17.44 | 3.52 |
| 59 | 18.10 |  | 15.27 | 41.15 | 10.54 | 57. 2 |  | 22.33 |  | 61.33 | 16.44 | 2.52 |
| 60 | 17.10 |  | 14.27 | 40.15 | 9.54 | 56. 2 |  | 21.33 |  | 60.33 | 15.44 | 1.52 |

# LUNAR OBSERVATIONS.

EXTRACTED FROM TH NAUTICAL ALMANAC.

## MEAN TIME.

### THE SUN'S

| Date. | Right Ascension | Declination. | Semidiam. | Equat'n of Time to be Subtr'd from Appar't Time. |
|---|---|---|---|---|
| 1834 | h m s | ° ′ ″ | ′ ′ | m s |
| Sept. 5th | ........ | 16.54.52 N. | 15.54 | 1.21 |
| " 6th | ........ | 6.32.32 | 15.54 | 1.40 |
| " 8th | ........ | 5 47.34 | 15.54 | 2.21 |
| " 9th | ........ | 5.24.56 | 15.55 | 2.41 |
| " 10th | ........ | 5. 2 12 | 15.55 | 3. 1 |
| " 11th | ........ | 4.39.24 | 15.55 | 3.22 |
| " 12th | 11.20.20 | 4.16.30 | 15.55 | 3.43 |
| " 13th | 11.23.55 | 3.53.33 | 15.56 | 4. 4 |
| " 23d | ........ | 0. 1. 5 N. | 15.58 | 7.35 |
| " 24th | ....... | 0.22.20 S. | 15 59 | 7.55 |
| " 29th | 12.21.28 | 2.19.27 | 16. 0 | 9.36 |
| " 30th | 12.25. 5 | 2.42.50 | 16. 0 | 9.56 |
| " 19th | 11.45.28 | 1.34.33 N. | 15.57 | 6.11 |
| " 20th | 11.49. 3 | 1.11.13 | 15.58 | 6.32 |
| " 21st | 11.52.39 | 0.47.52 | 15.58 | 6.53 |
| " 22d | 11.56.14 | 0.24.29 | 15.58 | 7.14 |
| Nov. 12th | 15. 8.51 | .......... | ...... | 15.41 |
| " 13th | 15.12.56 | .......... | ...... | 15.33 |
| **APPARENT TIME.** | | | | |
| 1824 | | | | |
| Mar. 4th | ........ | 6.19.54 S. | 16. 8 | ...... |
| Jun. 16th | ........ | 23.22.23 N. | 15.46 | ...... |
| " 17th | ........ | 23.24.26 | 15.46 | ...... |

## MEAN TIME.

### THE MOON'S

| Date. | SEMIDIAMETER. | | HOR. PARALLAX. | |
|---|---|---|---|---|
| | Noon. | Midn. | Noon. | Midn. |
| 1834 | ′ ″ | ′ ″ | ′ ″ | ′ ″ |
| Sept. 5th | ....... | 16.34 | ...... | 60.47 |
| " 6th | 16.31 | ...... | 60.37 | |
| " 8th | 16.12 | 16. 6 | 59.26 | 59. 4 |
| " 9th | ........ | ...... | ........ | |
| " 10th | 15.47 | 15.41 | 57.54 | 57.32 |
| " 11th | ........ | ...... | ........ | |
| " 12th | 15.24 | 15.19 | 56.30 | 56.11 |
| " 13th | 15.14 | ...... | 55.54 | |
| " 23d | ........ | 14.56 | ........ | 54.47 |
| " 24th | 15. 0 | ...... | 55. 2 | |
| " 29th | 16. 8 | 16.15 | 59.11 | 59.39 |
| " 30th | ........ | ...... | ........ | |
| " 19th | ........ | 14.42 | ........ | 53.57 |
| " 20th | 14.42 | ...... | 53.57 | |
| " 21st | ........ | 14.45 | ........ | 54. 7 |
| " 22d | 14.47 | ...... | 54.14 | |
| Nov. 12th | ........ | 14.43 | ........ | 54. 1 |
| " 13th | 14.43 | ...... | 53.59 | |
| **APPARENT TIME.** | | | | |
| 1824 | | | | |
| Mar. 4th | 15.12 | 15.16 | 55.47 | 56. 3 |
| Jun. 16th | ........ | 14.45 | .. ...... | 54. 9 |
| " 17th | 14.46 | ...... | 54.11 | |

## LUNAR DISTANCES,

EXTRACTED FROM THE NAUTICAL ALMANAC.

### MEAN TIME.

| Date. | Star's Name and Position. | Noon. | P.L. of Diff. | IIIh. | P.L. of Diff. | VIh. | P.L. of Diff. | IXh. | P.L. of Diff. | Midnig't | P.L. of Diff. | XVh. | P.L. of Diff. | XVIIIh. | P.L. of Diff. | XXIh. | P.L. of Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sept. | 1834 | ° ′ ″ | | ° ′ ″ | | ° ′ ″ | | ° ′ ″ | | ° ′ ″ | | ° ′ ″ | | ° ′ ″ | | ° ′ ″ | |
| 5th | Sun .....W. | 26.56.55 | 2403 | 28.20.25 | 2400 | 30.24. 0 | 2399 | 32. 7.36 | 2400 | 33.51.11 | 2401 | 35.34.44 | 2405 | 37.18.12 | 2409 | 39. 1.34 | 2414 |
| 8th | Sun .....W. | 67.45.26 | 2605 | 69.24.14 | 2620 | 71. 2.42 | 2635 | 72.40.49 | 2649 | 74.18.37 | 2665 | 75.56. 4 | 2681 | 77.33.10 | 2696 | 79. 9.56 | 2711 |
| 10th | Sun .....W. | 93.25.37 | 2849 | 94.59. 1 | 2863 | 96.32. 7 | 2879 | 98. 4.53 | 2894 | 99.37.20 | 2909 | 101. 9.28 | 2923 | 102.41.18 | 2938 | 104.12.49 | 2951 |
| 12th | Sun .....W. | 117.43.31 | 3073 | 119.12.14 | 3086 | 120.40. 1 | 3098 | 122. 8.53 | 3110 | | | | | | | | |
| 23d | Sun ......E. | 119.40.55 | 3390 | 118.18.27 | 3381 | 116.55.49 | 3372 | 115.33. 0 | 3363 | 114.10. 1 | 3352 | 112.46.50 | 3342 | 111.23.27 | 3331 | 109.59.52 | 3319 |
| 29th | Sun ......E. | 48.17.41 | 2612 | 46.39. 2 | 2595 | 45. 0. 0 | 2578 | 43.20.35 | 2561 | 41.40.47 | 2545 | 40. 0.36 | 2530 | 38.20. 5 | 2516 | 36.39.14 | 2502 |
| 12th | Fomalhaut E. | 47.23.31 | 3064 | 45.54.26 | 3095 | 44.26.10 | 3128 | 42.58.34 | 3163 | 41.31.40 | 3201 | 40. 5.32 | 3242 | 38.40.13 | 3287 | 37.15.46 | 3336 |
| 19th | Jupiter....E. | 58.44.20 | 3081 | 57.15.47 | 3083 | 55.47.17 | 3085 | 54.18.49 | 3086 | 52.50.22 | 3087 | 51.21.56 | 3087 | 49.53.31 | 3088 | 48.25. 7 | 3088 |
| 21st | Pollux ....E. | 75. 0.39 | 3083 | 73.32. 9 | 3081 | 72. 3.36 | 3079 | 70.35. 1 | 3077 | 69. 6.23 | 3074 | 67.37.42 | 3071 | 66. 8.57 | 3068 | 64.40. 8 | 3064 |
| 29th | Jupiter...W. | 66. 7.43 | 2273 | 67.54.22 | 2255 | 69.41.28 | 2237 | 71.29. 0 | 2220 | 73.16.58 | 2202 | 75. 5.22 | 2186 | 76.54.10 | 2170 | 78.43.23 | 2155 |
| Nov. 12th | Venus ...W. | 95.14.45 | 3301 | 96.38.56 | 3301 | 98. 3. 7 | 3300 | 99.27.19 | 3299 | 108.51.32 | 3298 | 102.15.46 | 3296 | 103.40. 2 | 3295 | 105. 4.19 | 3293 |
| **APPARENT TIME.** | | | | | | | | | | | | | | | | | |
| March | 1824 | | | | | | | | | | | | | | | | |
| 4th | Sun .....W | 40.37.37 | 3173 | 42. 4.18 | 3163 | 43.31.12 | 3151 | 44.58.20 | 3141 | 46.25.40 | 3130 | 47.53.13 | 1119 | 49.21. 0 | 3107 | 50.49. 1 | |
| June 16th | Sun ......E. | ........ | .... | ........ | .... | ........ | .... | ........ | .... | 119.50. 1 | 3438 | 118.28.27 | 3436 | 117. 6.51 | 3436 | 115.45.15 | 3435 |
| 17th | Sun ......E. | 114.23.39 | 3435 | 113. 2. 2 | 3432 | 116.40.22 | 3430 | 110.18.39 | 3428 | 108.56.54 | 3425 | 107.35. 6 | 3416 | 106.13.12 | 3416 | 104.51.14 | |

### THE MOON'S

| Date —1834. | Hours. | R. Ascension. | Declination. |
|---|---|---|---|
| Sept. 12th | 5 | 19h.26 .24s | 24°.16′.48 S. |
| " " | 6 | 19. 28. 45 | 24 .14 .31 |
| " " | 12 | 19. 42. 42 | 23 .58 . 6 |
| " " | 13 | 19. 45. 1 | 23 .54 .55 |
| " 19th | 20 | 1. 30. 16 | 4 .51 .26 N. |
| " " | 21 | 1. 32. 5 | 5 . 3 .33 |

### JUPITER'S

| Date.—1834. | R. Ascension. | Declination. | Hor. Par | Semid. |
|---|---|---|---|---|
| | h m s | ° ′ ″ | ″ | ″ |
| Sept. 19th | 4.40.21 | 21.18.54 N. | 1.83 | 19 88 |
| " 20th | 4.40.52 | 21.19. 7 | | |
| " 29th | 4.41.14 | 21.19.58 | 1.88 | 20.51 |
| " 30th | 4.41.15 | 21.19.56 | | |

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